Instruments

IE MAGAZINE of MEASUREMENT and CONTROL

Vol. 21 JANUARY 1948 No. 1

luding the JOURNAL of the Instrument Society of America

1928 TWENTIETH ANNIVERSARY 1948

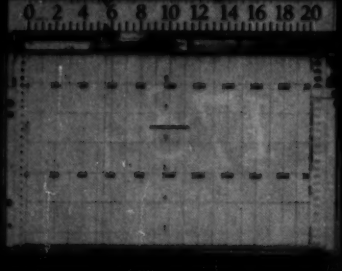
A "Historical Museum on Paper" of American Instruments in Science and Industry since 1784

DEPENDABILITY is important

"The mail must go through"—trite, but a fact nevertheless. The U. S. Postal System, through good times and bad, has built up an enviable reputation for unfailing service. *You can depend on the U. S. Mail!*

You Can Depend on **TAG** Instruments

Instrument men in every process industry have learned to "trust TAG". From fundamentals to fine points . . . correct design and rigid manufacturing standards combine to produce TAG instruments which are unbeatable for dependability. TAG manufactures all types of temperature and pressure indicators, recorders and controllers. Call your district TAG representative.



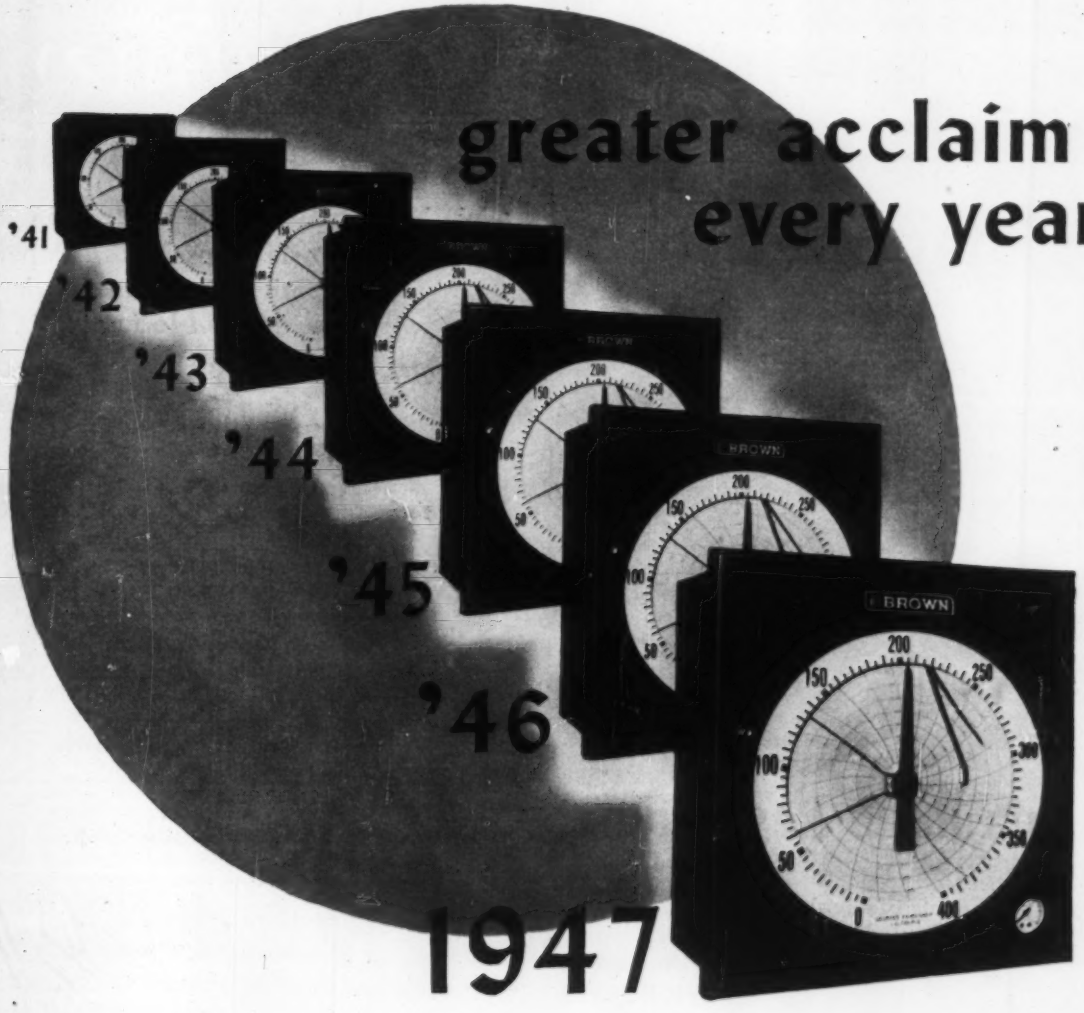
C. J. TAGliabue Mfg. Co.

549 Park Avenue Brooklyn 5, N.Y.

Representatives in Principal Cities

Always Specify TAG

SUBSIDIARY OF PORTABLE PRODUCTS CORP.



ElectroniK performance proved . . .

by *Seven years* in industrial service.

Each year industry accords greater acclaim to the Brown *ElectroniK* Potentiometer. Reviewing the record —seven years ago these "acclaims" were merely *claims* for a new and revolutionary type instrument.

In 1941 the story of the Brown *ElectroniK* was almost unbelievable. Today it is a proven reality backed by an unparalleled performance record.

Time has proven another important fact—the Brown *ElectroniK* Potentiometer requires only *negligible maintenance*. This fact alone is the reason why hundreds of plants have standardized on the Brown *ElectroniK*. Increasing purchases by previous users is gratifying proof to the men who have designed and manufactured this instrument.

Every year further substantiates the fact that the Brown *ElectroniK* Potentiometer is the most remarkable industrial instrument development of the decade.

THE BROWN INSTRUMENT CO., 4482 WAYNE AVE., PHILADELPHIA 44, PA.

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Subsidiary Companies in Toronto • Mexico City • London • Stockholm • Amsterdam • Brussels • Zurich

BROWN *Advanced Instrumentation* FOR BETTER PROCESSING

Product of MINNEAPOLIS Honeywell

FOR CONTINUOUS
AUTOMATIC PROPORTIONING
with *Maximum Accuracy*

The Askania Ratio Regulator

A simple, accurate way of mixing two or more liquids or gases to a predetermined ratio. Ratio can be changed easily without interruption of the process.

The Askania Ratio Regulator has only a few moving parts reducing maintenance to a minimum.

Low pressure systems use Fiberglas Diaphragms, measuring changes in conditions as small as .0025" W. C.

Turn down range of 10 to 1, with accuracy across full range.

For control of fuel/air mixtures, for mixing propane-butane and natural gas, for processing change from batch to continuous mixing... for proportioning two or more gases, liquids, or gases with liquids . . . use the Askania Ratio Regulator.

For detailed data get Technical Bulletin No. 101.

ASKANIA Controls

ASKANIA REGULATOR CO.
A Subsidiary of General Precision Equipment Corporation
246 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS
Export Office for Latin America: 44 Whitehall Street, New York, N.Y.

Instruments

Vol. 21 January 1948 No. 1

TWENTIETH ANNIVERSARY ISSUE

A "Historial Museum *on* Paper" *of* American Instruments *in* Science *and* Industry

EDITORIAL INTRODUCTION 33

First "Gallery" 35
EIGHTEENTH CENTURY
(Zenith Sector, circa 1784)

Second "Gallery" 35
NINETEENTH CENTURY TO DAWN OF ELECTRIC POWER AGE

Third "Gallery" 37
FROM DAWN OF ELECTRIC POWER TO END OF WORLD WAR I

Fourth "Gallery" 46
FROM END OF WORLD WAR I TO DAWN OF ELECTRONICS IN INDUSTRY

Instruments on the March

Automatic Flight—Official Account 6
Glass-blowing Skill 10
Tiny Pick-ups Measure Strains in Huge Machine 12

LETTER TO THE EDITOR 12
Problems in Medical-apparatus Instrumentation

New Instruments Department 76

Other Regular Features

"WHEN A FELLER NEEDS CONTROL" 8
MANUFACTURERS' NEW LITERATURE 88
ADVERTISERS' INDEX 92

JOURNAL of the INSTRUMENT SOCIETY OF AMERICA 79

INDEX to Vol. 20 (1947) will appear in next issue

Instruments The Magazine of Measurement and Control is published monthly on the 15th by The Instruments Publishing Co., Inc. 1117 Wolfendale St., Pittsburgh 12, Pa.

Richard Rimbach, *Publisher* — M. F. Béhar, *Editor*

DISTRICT OFFICES AND MANAGERS

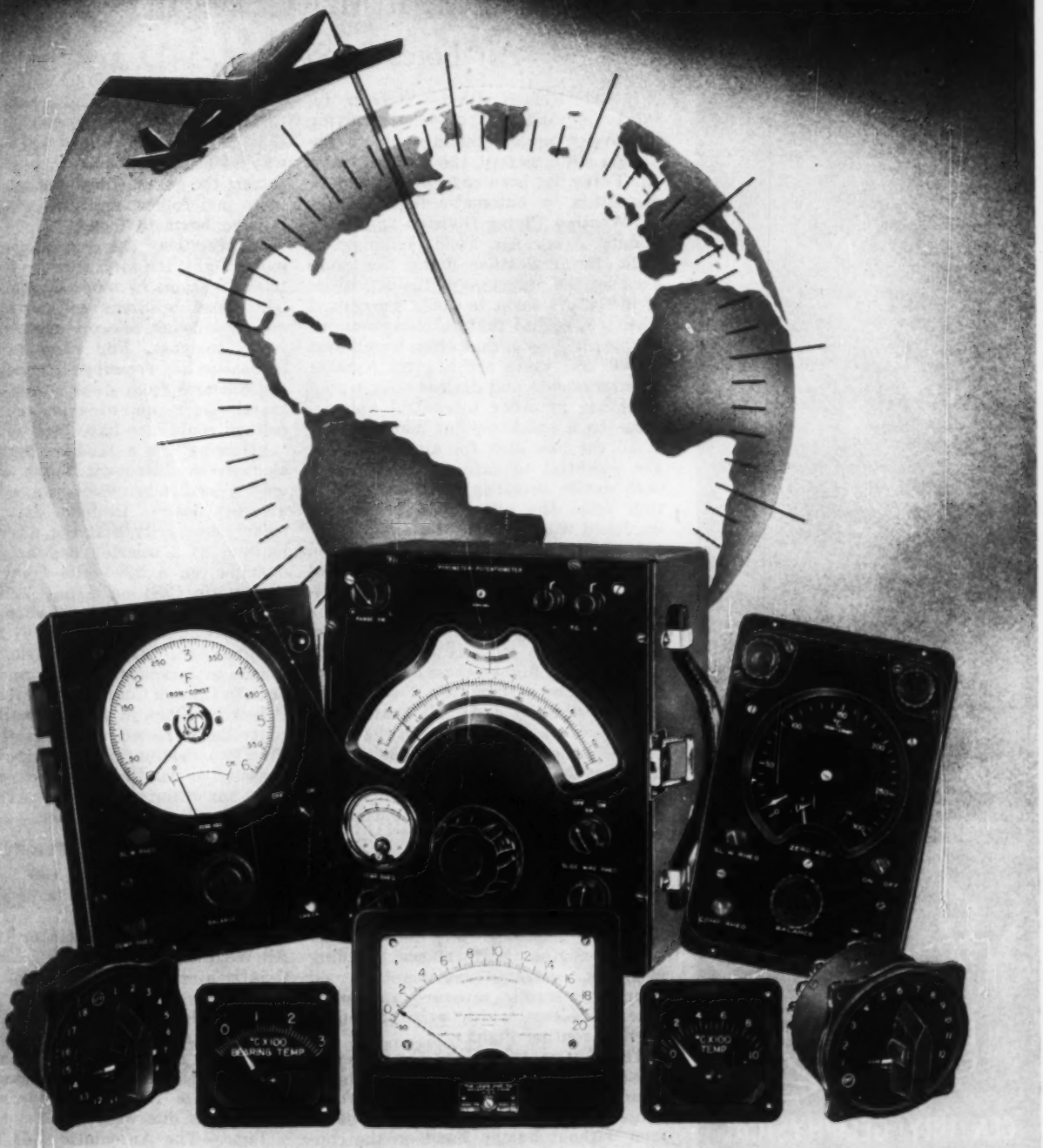
MEMBER ABC Audit Bureau of Circulations

James Condon, 36 Myrtle St., *Boston* 14, Mass. (Lafayette 3-0829). Stuart Rogers, Room 928, 17 East 42nd St., *New York* 17, N. Y. (Murray Hill 2-0821). Harold W. Haskett, 742 Elberon Ave., *Cincinnati* 5, Ohio (Grandview 4323); Room 615, 360 N. Michigan Ave., *Chicago* 1, Ill. (Andover 4299). James R. Wright, 915 Olive St., *St. Louis* 1, Mo. (Chestnut 1965). M. D. Pugh, 2721 N. Marengo Ave., *Altadena*, Calif. (Sycamore 7-2894). C. F. Goldcamp, 1117 Wolfendale St., *Pittsburgh* 12, Pa. (Fairfax 0161).

SUBSCRIPTION RATES: United States and U. S. possessions: one year $3, two years $5, three years $6; Canada, Latin America and Australia: one year $4, two years $6, three years $8; all other countries except those noted below: one year $5, two years $8, three years $10; Austria, Bulgaria, Czechoslovakia, Germany, Hungary, Poland, Romania, Russia and Jugoslavia: one year $7, two years $11, three years $15. Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. bank. Position and company connection as well as products manufactured must be indicated on all subscription orders.

Copyright 1948 by The Instruments Publishing Company. Entered as second-class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

PROVEN *around the* WORLD *for* ACCURACY



THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

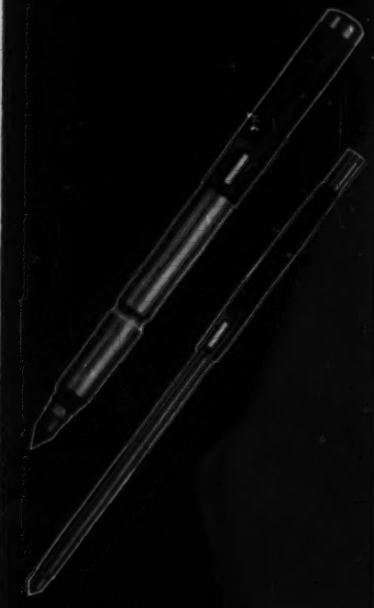
• NAUGATUCK, CONNECTICUT. •

POTENTIOMETERS • • • • • • SELECTOR SWITCHES • • • • • • • • • THERMOCOUPLES •
PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

Century

GALVANOMETERS

Available with natural frequencies from 15 c.p.s. to 1500 c.p.s., electromagnetically damped and to sensitivities as high as 2" per microampere at 1 meter focal distance.



CENTURY TUBULAR TYPE GALVANOMETERS

The Model G-14 in hard chrome plated brass tube and the Model 205 of heat-treated, non-magnetic stainless steel. Rugged and durable, yet possesses extreme sensitivity. Internal suspensions are manufactured by a patented process which provides unequaled balance. Hermetically sealed giving maximum efficiency under all climatic conditions.

Century

CENTURY GEOPHYSICAL CORPORATION

Tulsa, Oklahoma

NEW YORK 149 Broadway

HOUSTON Niels-Esperson Bldg.

World's Largest Manufacturer of Geophysical and Special Galvanometers

INSTRUMENTS ON THE MARCH

Automatic Flight

Air Force Report of C-54D Test

WILMINGTON, Ohio.—Striving toward the reality [illegible] by developing a[n] proved flying sa[fety] Air Force has b[een] mentation in a[n] All-Weather Fly[ing] County Army [Air Field] Ohio. In all-we[ather] need for the red[uction] of the pilot's ta[sk] when we realize[d] engine air giant[s] 60,000 lbs., ther[e] of instruments [he] must use in or[der] plane on a poin[t].

All the new [devices] are essential t[o] each device de[ter]tion from the [pilot] burdened with [routine] second decisions [about] the plane in a [crisis] must have mo[re] sions, to reduc[e] he must turn, [what] watch and the [order] dinate during fl[ight] that must be [made] is to be a reali[stic] ing conditions. [Pilots] can be made a[ware] tion that the pi[lot] for him by an [automatic] entire flight fr[om] can be made [practical] having the plane guided by an external source such as in the system that is used with radio-controlled drones. This leaves the pilot with ample time to make necessary decisions on weather, air traffic, engine performance, loading problems, gasoline consumption, oil supply, hydraulic pressure and many other problems which arise during a normal routine flight.

The Automatic Flight Controller is the system being developed at Clinton County Army Air Field, to control a large aircraft through its entire mission without human hand on the controls in the air or on the ground. This is not a remote radio controller, but consists of a "brain" that stores information given to it before the flight begins, "reads" the flight instruments, listens to the radio signals, measures the distances and air speed and carries out for the pilot and his crew all the functions necessary to conduct a point to point flight from one airfield to another. Its memory circuits hold the [information given to it, so that in reading]

A more spectacular test was [made] transatlantic flight, the facts of which follow:

Mission.—On 20 September 1947, [the] All-Weather Flying Center's Automat[ic] C-54D aircraft left Clinton Coun[ty] Army Air Field, Wilmington, O., [for] Stephenville, Newfoundland. From tak[e] off point at Stephenville, the C-54 completed a fully automatic transatlantic crossing to Brize Norton, England. (Brize Norton is approximately forty miles due west of London.)

Time.—The Automatic C-54 took [off] from Clinton County Army Air Field, Wilmington, Ohio at 8:01 a.m. EST, September 20, 1947. The aircraft arrived at Westover Field, Mass. at 11:[41] a.m. EST. Departing Westover Field at 1:41 p.m. EST, it arrived at Stephenville, Newfoundland at 6:10 p.m. EST.

On September 21, 1947, at 5:15 p.m. EST the Automatic C-54 left Stephenville, Newfoundland for the trans[atlantic]

TIG

BO

GHTLY

OUND

NORKS — Connecting rod A, mov- down with expansion or contraction , transmits vertical motion to meter ing, pivoted at flexible portion G. ft, *sealed off from the rest of the* , is attached to shaft housing at E, rank arm D-E. Movement of shaft rns crank arm, rotating meter shaft ry bearings B and C, and actuating through connecting link F. Thus, the through transmitted motion of the bel- rds differential pressure in terms of w.

TERS are your log- utomatic control

A STOCK ITEM

Bellows-Differential Flow Meters are carried in stock for *immediate* shipment.

Bristol Bellows-Differential Flow Meters use no mercury or other liquid in the meter body . . . require no accurate levelling or corrections for liquid over mercury . . . eliminate pressure-tight bearings and stuffing boxes, along with pivots, chains, ground joints and knife edges . . . make lubrication unnecessary . . . *and the meter shaft is completely sealed off from corrosive contact with the measured fluid.*

Compared with mercury-type meters, this extreme simplicity of design results in far less inertia in moving parts and, therefore, much quicker response to variations in pressure.

Offered as: Mechanical Flow Meters . . . Electric Flow Meters . . . Pneumatic Transmission Components

Bristol Bellows-Differential Flow Meters and their many applications are described in Bulletin F1603. For your copy, address The Bristol Company, 113 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada Ltd., Toronto, Ontario. Bristol's Instrument Co., Ltd., London N. W. 10, England.)

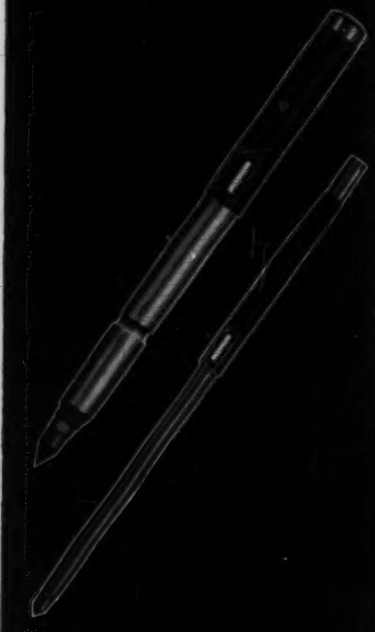
BRISTOL

Engineers process control for better products and profits

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

Century
GALVANOMETERS

Available with natural frequencies from 15 c.p.s. to 1500 c.p.s., electromagnetically damped and to sensitivities as high as 2" per microampere at 1 meter focal distance.



CENTURY TUBULAR TYPE GALVANOMETERS

The Model G-14 in hard chrome plated brass tube and the Model 205 of heat-treated, non-magnetic stainless steel. Rugged and durable, yet possesses extreme sensitivity. Internal suspensions are manufactured by a patented process which provides unequaled balance. Hermetically sealed giving maximum efficiency under all climatic conditions.

Century

CENTURY GEOPHYSICAL CORPORATION

Tulsa, Oklahoma

NEW YORK
149 Broadway

HOUSTON
Niels-Esperson Bldg.

World's Largest Manufacturer of Geophysical and Special Galvanometers

INSTRUMENTS ON THE MARCH

Automatic Flight

Air Force Report of C-54D Test

WILMINGTON, Ohio.—Striving toward the reality of all-weather flying by developing and testing aids to improved flying safety, the United States Air Force has been carrying on experimentation in automatic flight at the All-Weather Flying Division at Clinton County Army Air Field, Wilmington, Ohio. In all-weather flying the great need for the reduction of the difficulties of the pilot's tasks is easily recognized when we realize that in today's multi-engine air giants, that often weigh over 60,000 lbs., there are a great number of instruments and devices that a pilot must use in order to control his airplane on a point-to-point flight.

All the new aids for aircraft safety are essential to safe flight, although each device demands additional attention from the pilot, who is already burdened with the job of making split-second decisions to take-off, fly and land the plane in a safe manner. The pilot must have more time for these decisions, to reduce the number of knobs he must turn, the instruments he must watch and the controls he must coördinate during flight—these are problems that must be surmounted if safe flight is to be a reality under all weather flying conditions. If each step in the flight can be made automatic and each function that the pilot performs can be done for him by an automatic mechanism, the entire flight from take-off to touchdown can be made without pilot action or having the plane guided by an external source such as in the system that is used with radio-controlled drones. This leaves the pilot with ample time to make necessary decisions on weather, air traffic, engine performance, loading problems, gasoline consumption, oil supply, hydraulic pressure and many other problems which arise during a normal routine flight.

The Automatic Flight Controller is the system being developed at Clinton County Army Air Field, to control a large aircraft through its entire mission without human hand on the controls in the air or on the ground. This is not a remote radio controller, but consists of a "brain" that stores information given to it before the flight begins, "reads" the flight instruments, listens to the radio signals, measures the distances and air speed and carries out for the pilot and his crew all the functions necessary to conduct a point to point flight from one airfield to another. Its memory circuits hold the information given to it, so that in reading the flight instruments, it knows which way to head, how fast to go, when to retract the gears, which stations to tune in to and follow, and finally on which landing beam to "home".

In presetting the course of an automatic flight, the aircraft may be guided to destinations by more than one method. Preset headings can be based on an air-mileage selector method or by radio compass. For example in the transatlantic crossing, "homing" on radio beams from ships at sea was optional since an air-mileage counter method could also have been selected.

"Homing" on a landing beam is an element in automatic flight which is used specifically when the automatic aircraft desires to land. It does not mean necessarily that the aircraft has to land at a selected destination. For example, on a 2900-mile flight of the Automatic C-54 on Sept. 11, the aircraft flew to three destinations—from Clinton County Army Air Field, Wilmington, O., to Presque Isle, Maine, thence to Jacksonville, Fla., and finally back to Clinton County Army Air Field. Preset headings in the automatic flight controller directed the aircraft to the first two destinations in turn but the preselected landing sequence was set only for Clinton County Army Air Field, the third destination.

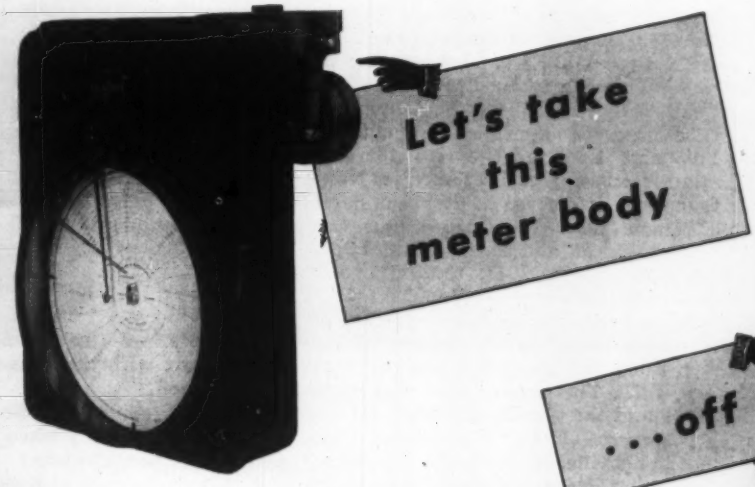
Transatlantic Flight

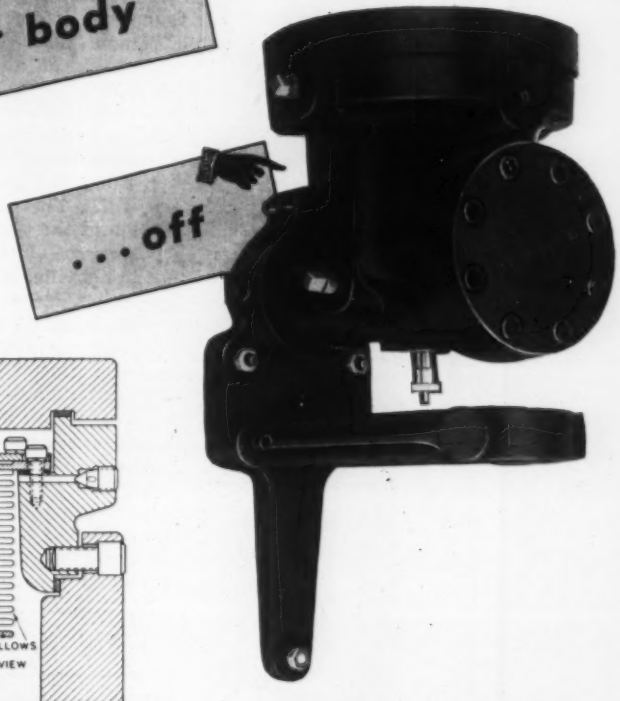
A more spectacular test was the transatlantic flight, the facts of which follow:

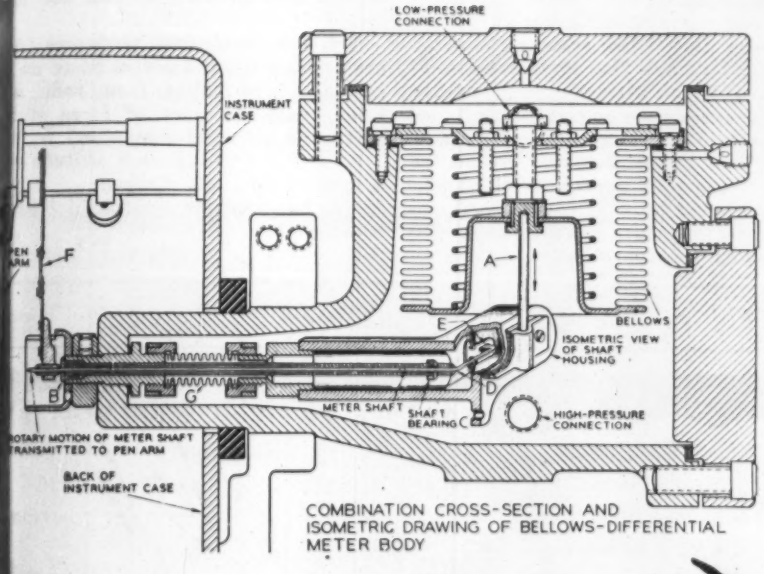
Mission.—On 20 September 1947, the All-Weather Flying Center's Automatic C-54D aircraft left Clinton County Army Air Field, Wilmington, O., for Stephenville, Newfoundland. From take-off point at Stephenville, the C-54 completed a fully automatic transatlantic crossing to Brize Norton, England. (Brize Norton is approximately forty miles due west of London.)

Time.—The Automatic C-54 took off from Clinton County Army Air Field, Wilmington, Ohio at 8:01 a.m. EST, September 20, 1947. The aircraft arrived at Westover Field, Mass. at 11:01 a.m. EST. Departing Westover Field at 1:41 p.m. EST, it arrived at Stephenville, Newfoundland at 6:10 p.m. EST.

On September 21, 1947, at 5:15 p.m. EST the Automatic C-54 left Stephenville, Newfoundland for the transa-







COMBINATION CROSS-SECTION AND ISOMETRIC DRAWING OF BELLOWS-DIFFERENTIAL METER BODY

HOW IT WORKS — Connecting rod A, moving up or down with expansion or contraction of bellows, transmits vertical motion to meter body housing, pivoted at flexible portion G. Meter shaft, *sealed off from the rest of the meter body*, is attached to shaft housing at E, forming crank arm D-E. Movement of shaft housing turns crank arm, rotating meter shaft in stationary bearings B and C, and actuating pen arm through connecting link F. Thus, the pen arm, through transmitted motion of the bellows, records differential pressure in terms of rate of flow.

. . . and look inside

. . . to see why BRISTOL BELLOWS-DIFFERENTIAL FLOW METERS are your logical choice for indicating, recording, integrating and automatic control

A STOCK ITEM

Bellows-Differential Flow Meters are carried in stock for *immediate shipment.*

Bristol Bellows-Differential Flow Meters use no mercury or other liquid in the meter body . . . require no accurate levelling or corrections for liquid over mercury . . . eliminate pressure-tight bearings and stuffing boxes, along with pivots, chains, ground joints and knife edges . . . make lubrication unnecessary . . . *and the meter shaft is completely sealed off from corrosive contact with the measured fluid.*

Compared with mercury-type meters, this extreme simplicity of design results in far less inertia in moving parts and, therefore, much quicker response to variations in pressure.

Offered as: Mechanical Flow Meters . . . Electric Flow Meters . . . Pneumatic Transmission Components

Bristol Bellows-Differential Flow Meters and their many applications are described in Bulletin F1603. For your copy, address The Bristol Company, 113 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada Ltd., Toronto, Ontario. Bristol's Instrument Co., Ltd., London N. W. 10, England.)

BRISTOL

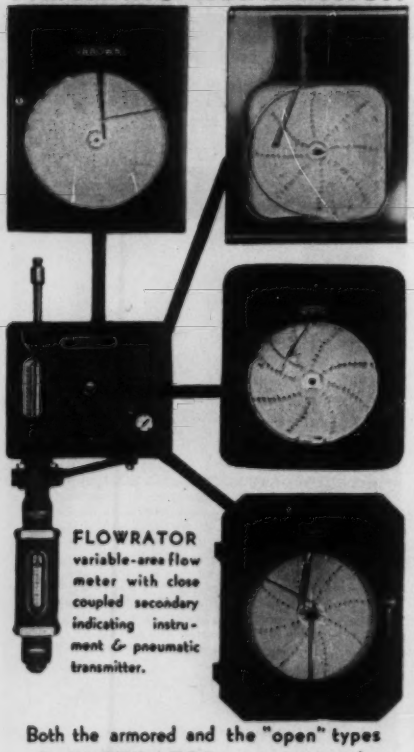
Engineers process control for better products and profits

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

ANY MAKE OF INSTRUMENT ON YOUR PANEL BOARD CAN OPERATE FROM

FLOWRATOR METERS

BY PNEUMATIC TRANSMISSION



FLOWRATOR variable-area flow meter with close coupled secondary indicating instrument & pneumatic transmitter.

Both the armored and the "open" types of FLOWRATOR instruments for measuring fluid flows are available with pneumatic transmitters used to actuate the remote receivers made by any of the better-known instrument manufacturers. No coordination of the instruments before shipping is necessary. All you need to do is connect the air lines and adjust one screw in the transmitter till the readings of transmitter and receiver agree.

The F & P pneumatic transmitter is the most modern and simple available. Both the pilot and the relay valve are built together as one single unit. That is why the transmitter case is so small though it includes a full 5" long indicator scale.

SEND FOR CATALOG 55 FOR DETAILS OF F&P PNEUMATIC TRANSMITTERS.

FISCHER & PORTER CO.
DEPT. 8L-5C HATBORO, PA.

FLOWRATOR

lantic crossing to Brize Norton, England. The aircraft arrived at Brize Norton at 5:20 a.m. EST. The elapsed time was twelve hours and five minutes.

On October 7, 1947, the Automatic C-54 departed Lyneham, England at 1:05 a.m. EST for the return transatlantic crossing to Stephenville, Newfoundland. It arrived at Stephenville at 3:16 p.m. EST. The elapsed time was fourteen hours and eleven minutes.

On October 8, 1947, the Automatic C-54 departed Stephenville, Newfoundland, at 7:32 a.m. EST, and arrived at its home base, Clinton County Army Air Field, Wilmington, Ohio at 4:11 p.m. EST. The elapsed time was eight hours and thirty-nine minutes.

Distances.—From Wilmington, Ohio to Stephenville, Newfoundland, approx. 1490 miles. From Stephenville to Brize Norton, approx. 2400 miles. Distances flown on the automatic flights totaled approximately 7,780 statute miles.

Flight Plan.—The Automatic C-54 flew the North Atlantic route on the transatlantic crossings and maintained a predetermined barometric altitude of 9,000 feet. The Automatic C-54 carried a fuel supply of approx. 3,700 gallons on each crossing.

Flight Procedure to England.—One button on the control panel, a button marked "Brize Norton, England" was pushed. This was the only manual operation during the entire flight. The automatic flight was carried out in twelve sequences by a self-contained mechanism, the master sequence selector, without the aid of any human guidance such as a pilot on the ground or "mother" ship. No outside force directs the Automatic C-54D. No human hand inside touches the controls.

The twelve sequences of the automatic flight are:

1. Pre-takeoff (manual alignment of the aircraft with the runway).
2. Takeoff.
3. Initial climb (Landing gear retracted automatically when the aircraft reaches 50 feet altitude.)
4. Climb to cruise altitude (Flaps retracted automatically at 1000 feet altitude.)
5. 6. 7. 8. Navigation sequences (Aircraft flies a ground course based on directional information from radio stations, magnetic lines of force of the earth and air miles computor.)
9. Descent to approach altitude over a preselected radio station.
10. Approach on localizer direction beam.
11. Final approach and descent

WHEN A FELLER NEEDS CONTROL

By Phil Putnam

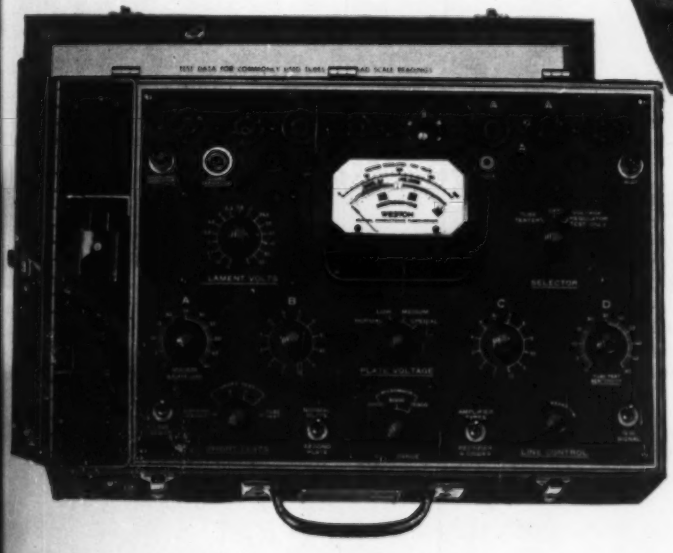
MIKE-TH' FURNACE IS RIGHT · THOSE CONTROLS ARE — H·H·EY T·TAKE IT EASY!
YAH! SEE FOR YOURSELF! WHY I COULD USE THIS INSTEAD OF ICE IN MY ICEBOX — I SAY THIS FIRE IS 10° LOW AND THAT YOUR CONTROL IS WRONG!
2400°F!
PJ

IDEA BY:
SID SPUNGIN
METALLURGICAL LAB, AMERICAN BOSCH CORP., SPRINGFIELD, MASS.

Instruments pays $5.00 for each idea used. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so.
Address Cartoon Dep't, *Instruments*, 1125 Wolfendale St., Pittsburgh 12, Pa.

INSTRUMENTS FOR
ELECTRONIC MAINTENANCE

WESTON *Electronic Analyzer* — Model 769. Incorporating: 1. A conventional Volt-Ohm-Milliammeter with self-contained power source. 2. A high-impedance electronic Volt-Ohmmeter using 115 volt, 60 cycle power. 3. A stable, probe-type, Vacuum Tube Voltmeter, for use to 300 megacycles.



WESTON *Multi-Purpose TUBECHECKER* — Model 798. This universal tubechecker offers within one instrument provision for testing: 1. Receiving tubes. 2. Voltage regulator tubes. 3. Light duty thyratron tubes such as 2A4—6D4—884—885—2051. Scale is calibrated "Good-Bad" as well as in mutual conductance readings.

Direct Reading Insulation Tester — Model 799. Compact, one-hand-operated insulation tester with .1 to 10,000 megohm range, using a test potential less than 50 volts d-c. Indicates: 1. Insulation properties. 2. Leakage resistance. 3. Conductivity of insulating materials. 4. Leakage due to moisture absorption.

These portable Westons are specifically designed for expediting electronic maintenance . . . for doing the job better—faster. All are engineered and built in the strictest traditions of Weston accuracy and dependability. For further details see your local WESTON representative, or write . . . Weston Electrical Instrument Corporation, 591 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON
Instruments

LEAKY check VALVES?

TWIN SEAL Check Valve

GENERAL PURPOSE HAND PUMP

HOLD UP TO 20,000 psi

with

TWIN SEAL CHECK VALVE & GENERAL PURPOSE PUMP

Twin Seal Check Valve
assures absolutely leakproof performance at pressures up to 20,000 psi . . . even with grit.

General Purpose Hand Pump
recommended for use in test stands . . . for hydrostatic testing . . . source of power for hydraulic jacks, small hydraulic presses or similar applications where pressure leakage is objectionable.

Custom Built Hand Pumps
may be an adaptation of the general purpose pump illustrated, or special pumps fabricated entirely of bar stock parts machined from alloys to meet specific conditions.

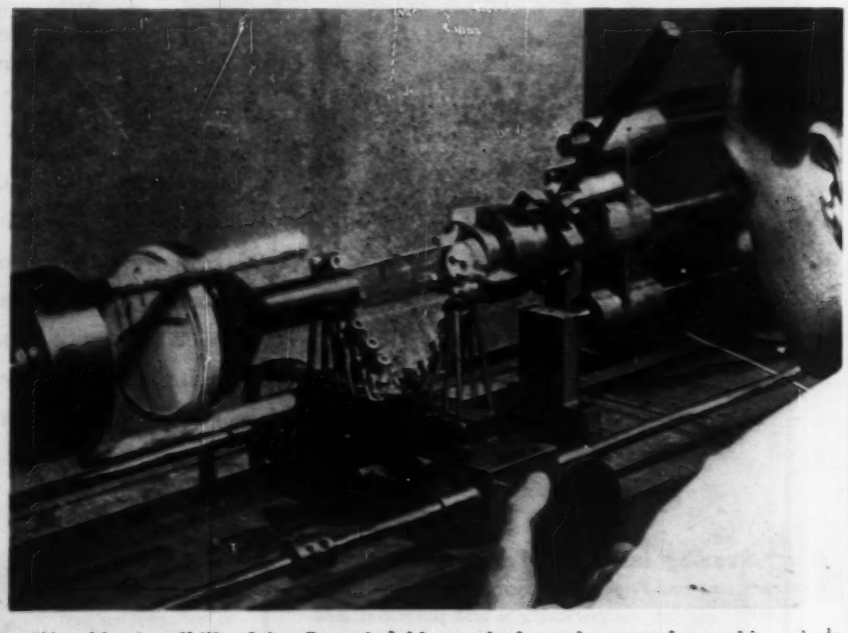
Write for Bulletin

MANSFIELD & GREEN
1051 Power Avenue CLEVELAND 14 O

localizer directional beam and glide path beam.

12. Landing.

The entire flight, from take-off to landing was automatic. All flight data were preset on the special control panel instruments of the master sequence selector. Preset flight data included cruising altitude, cruise heading, mileage to destination, cruising speed, rate of climb and descent. The master sequence selector is located in the main cabin and is powered by an auxiliary gasoline generator. The navigational phase of the flight is controlled by two mileage counters and magnetic heading selectors. These instruments control the flight until the plane clicks off the preset number of miles on the predetermined heading. At the end of the first

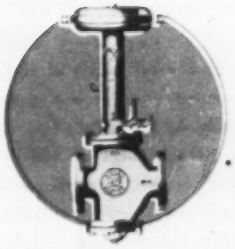


Glass-blowing Skill.—John Casucci deftly manipulates the controls on this cathode-ray tube lathe at the Dobbs Ferry, N. Y. plant of North American Philips Company, Inc. He is "sealing-on" a new tube neck.

Better Control Valves

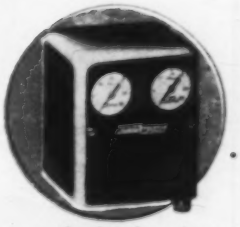
OPEN NEW ROADS TO

Better Processing



• Diaphragm Valves

• Liquid Level Controls



• Pressure Pilots

. . . and related equipment for steam, gas, air and liquid services.

● With the *new* K & M regulators the process industries get a green light to more accurate, trouble-free control of pressures, flows, temperatures, and liquid level.

The reason is simply this: *K & M engineers* were given a green light when the line was designed. "Forget what's been done in the past," they were told. "Produce something better . . . to meet the process industries' needs *today*."

Kontrol Motor Regulators are their answer. *New* light weight. *New* diaphragm materials. *New* accuracy. *New* speed in getting at the diaphragm for inspection—for (typical of the K & M approach) better design has done away with casing bolts, considered "necessary" for years!

Kieley & Mueller engineers combine the most up-to-date equipment offered today with their company's half-century background of experience. They are eager to apply this combination to the solution of your control valve problems, new installations or replacements.

Write for the new K & M catalog and names of Kieley & Mueller representatives from coast to coast.

KONTROL KIELEY & MUELLER MOTOR

NORTH BERGEN N.J.

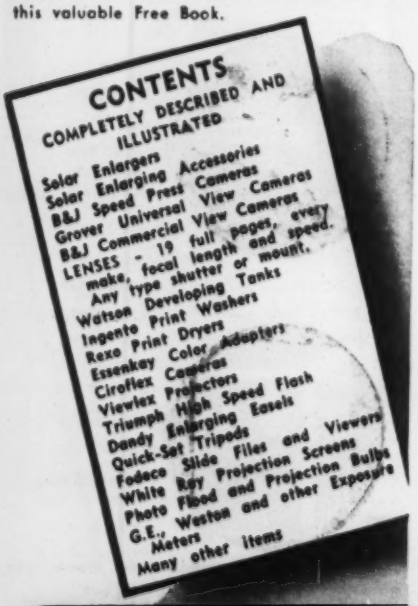
FREE BOOK

Burke & James

50th. Anniversary

64 PAGE PHOTOGRAPHIC EQUIPMENT CATALOG

The most complete catalog ever published by the manufacturers of the famous SOLAR Enlargers, B&J Speed Press Cameras, GROVER and B&J View Cameras. Fully illustrates and describes hundreds of items every photographer needs. Nineteen full pages of lenses of every make and description from one half inch to 80 inch focal lengths. Cine, Commercial, portrait and process. The most complete lens stock available! Everything photographic from America's leading photographic manufacturer and supply house. Write today for this valuable Free Book.



Burke & James, Inc.

MANUFACTURERS FOR 50 YEARS

Dept. I-1, 321 S. Wabash Ave., Chicago 4, U.S.A.

navigational sequence, the aircraft "homed" automatically to a radio station located on a ship in the mid-Atlantic. At the end of the second navigational sequence, the clicking-off of the last mile on the counter threw control to the radio compass which homed in on radio station BBC at Droitwich. Final descent was geared to the AAF Instrument Low-Approach system (SCS-51 localizer and glide path) at Brize Norton. [Note: Final descent may be geared alternatively to the Sperry Microwave Landing System.]

The present Automatic Flight Controller Mark Two is the second model designed and installed in the C-54. Many times during the test flights of the first model, the equipment was held together literally with "wires and bits of string." The big problem of reducing to practicality the theories proved in the first model and making them reliable for routine scheduled airline use, was attacked in designing the Automatic Flight Controller Mark Two. The design and installation was under the direction of Mr. James Anast.

Tiniest Pick-ups Measure Strains in Biggest Machine

NORTH GRAFTON, Mass.—The giant and the midget in engineering teamed up here recently in the Wyman-Gordon magnesium forging plant. The giant was a huge Mesta forging press, largest in the world, weighing 5,000,000 lbs. and capable of developing a force in excess of 19,350 tons. The midget was a tiny Baldwin "SR-4" strain gage, about the weight of a paper clip and about the size of a postage stamp. Four of these small gages were attached to *each* of the four steel columns of the tremendous press, at 90° to one another circumferentially. Purpose was to determine strains due to direct axial load and to eliminate effects of strains due to bending.

Strain readings in microinches per inch were taken for each gage. The first set of readings was taken when the dies were completely disengaged. Under these conditions the weight of the platen, top die, main rams, etc., was carried by the push-back rams. At this time also, owing to the valve arrangement, hydraulic fluid was trapped in the main cylinders and intensified to approximately 650 lbs./in.^{2}. This produced an upward reaction.

With the plate lowered so that the weight of the platen, top die, etc., was transferred from the push-back rams to the lower die, the second set of strain measurements was made. A decrease in tension load on the columns was revealed, due primarily to the release of the intensified fluid in the main cylinders. Full pressure of 5500 lbs./in.^{2} was then applied to the main rams and a third set of readings taken. Main cylinder pressure was released and a fourth set of readings of all gages taken with dies in contact, and a fifth set with dies out of contact.

The entire set of readings was repeated to provide a second set of data. The upward reaction on the main cylinders, top platen, etc., under condition of "dies in contact" is about 1,630,000 lbs. This probably equals or exceeds the weight of the parts so that there may be a small tensile stress in the columns under this condition.

Results, according to engineers, indicate higher strains on the areas of the columns next to the dies which is considered rational. Conclusions: (1) the total load capable of being exerted by the press is about 19,350 tons, plus the weights of the moving parts but exclusive of the push-back rams; (2) tween "dies free" and "full load" the change of loads on the columns bevaries among the four columns by no more than 8% of the value of that load change on the column showing the smaller load change.

LETTER TO THE EDITOR

Problems in Medical Apparatus Instrumentation

December 10, 1947

To the Editor of *Instruments:*

As one of your constant readers I stand indebted to you and the magazine you edit for a great deal of useful information, but this letter is prompted especially by your editorial, "Electron Tubes in Instrumentation" in the November issue of *Instruments.*

Possibly I am engaged in one of the least exploited fields of instrumentation, or at least it feels that way. Despite the physical mechanisms which seem to work so well in the normal body, medical men have made little use of physical methods of treatment except for those which are characterized by not occurring in the normal human body. I refer to x-rays, diathermy, electrical stimulating devices, ultraviolet rays, infrared rays, electrolysis, ion transfer through the skin, and many other physical therapeutic methods. These are of great value in medicine, but we still have not tackled the problem of replacing the physical mechanisms of the body in any orderly way.

In fact, most of our advances have come by the work of men not in the medical profession; examples including: eyeglasses, hearing aids, artificial limbs, dentures, contact lens, trusses, and many others. These are adopted by medicine once they have been worked out, but it is increasingly difficult for persons untrained in medicine to evaluate the problem well enough to make organ substitutes for other organs, or improved mechanisms for bedside care. I am trying to fill in the gaps by designing synthetic organ devices and bedside nursing devices, starting from the medical side of the fence.

Your remarks about electron tubes

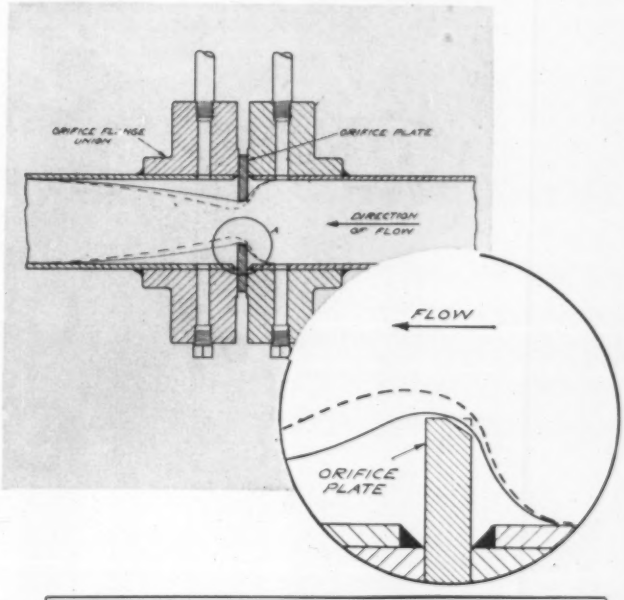
BACK UP FLOW METER ACCURACY

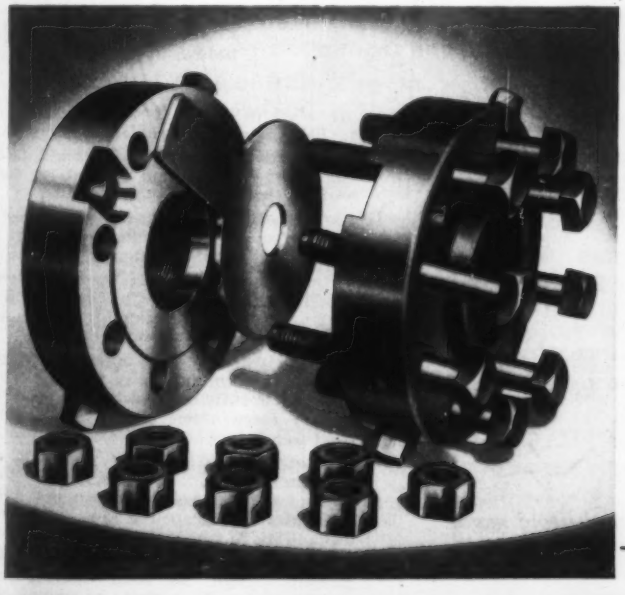
with Accurately-made Orifice Plates

THE PRECISION TOLERANCES of Foxboro Orifice Plates may seem extreme, but results over the years have paid off in worthwhile savings to users. These thin-plate, square-edge orifices are bored to an accuracy of 1/20th of 1% of the orifice diameter . . . which means a measuring accuracy within 1/10 of 1% (0.001).

The importance of the *square* leading edge can be seen from the diagram at the right. If the upstream edge of the orifice is dulled to a radius of as little as .005", it's equivalent to an orifice bored .01" too large . . . resulting in an error in flow measurement of as much as 2% or more, depending on orifice size.

Naturally, orifice plates made to close limits of accuracy require careful storage and handling. They are and should be regarded as a very important part of the flow meter installation.





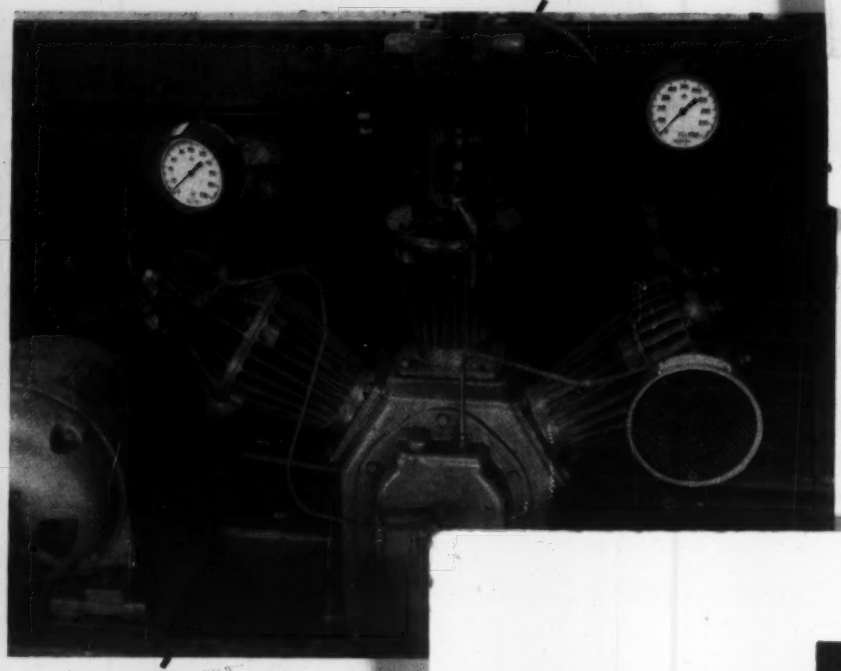
Check these Advantages of FOXBORO Orifice Plates

- ★ **Precision bored, with square upstream edge, for maximum accuracy**
- ★ **Supplied in metal best suited to specific service conditions**
- ★ **Bored plates enclosed in individual envelopes for protection during shipment and storage**
- ★ **Easy to install between union flanges**
- ★ **Data always visible on projecting tabs**
- ★ **Low in cost**

Write, giving available details of your metering problem, for further details on Foxboro Orifice Plates. (Foxboro also furnishes flow nozzles, Venturi tubes, and Pitot tubes, whenever requirements call for these alternative primary elements.) We'll gladly send bulletin which describes Foxboro Flow Meters as well. Address: **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U. S. A.**

FOXBORO REG. U. S. PAT. OFF. **ORIFICE PLATES**

Here's how HELICOID GAGES

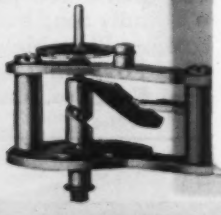


PAY

On a compressor like this, v
rapid pressure pulsations, ord
movements last but a short ti
worn out in a few weeks.

By comparison, Helicoid ga
the gages shown here have bee
are still going strong.

This is an example of the sav
be made by using Helicoid—th



ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

have come at a good time to enfo
my belief that they must be u d wi
caution in apparatus where f lure
operation may subject a pa ent
trauma. Many of my designs a e ma
to relieve a nurse of a tedio bit
work, but she must know that the a
paratus is trustworthy or she ill ha
to worry about both the patient nd t
apparatus. . . .

[Description and detailed discussion

MA

physician's training is not adapted.

Since the average physician has o
one course of Physics before he ente
medical school and none thereafter, yo
can see how he is handicapped in th
use of Physics in his therapy. Yet som
of my worst problems are with suc
men who want me to do everything wit
the aid of electronic devices. It ma
please you to know that I use mecha
cal clocks instead of relaxation oscilla
tors, hydraulics instead of elabora
pumps and flow equipment, and whe
I have to use electrical thermostats
put them in series to open and paral

PAG

MISS

available, . . . The effects of suction on t
capillary bed is an example of one of the
common considerations.

[The other enclosure was a reprint of
description of an already-perfected drainag
apparatus. Readers who can help Dr. Mac
Neill solve his measurement and automatic
control problems will advance medica
science by communicating with him. W
trust that the good Doctor isn't prejudice
against electronic instruments. We are not
—EDITOR]

GES

SING

With a Telechron motor you give your product the plus value of Telechron leadership. For over 25 years, Telechron has been the largest producer of synchronous electric motors. Every one is Underwriters Laboratories approved. Telechron *application engineers* will be glad to discuss your needs. Address Motor Advisory Service, Dept. B, Telechron Inc., Ashland, Massachusetts.

See our CATALOG in SWEET'S FILE

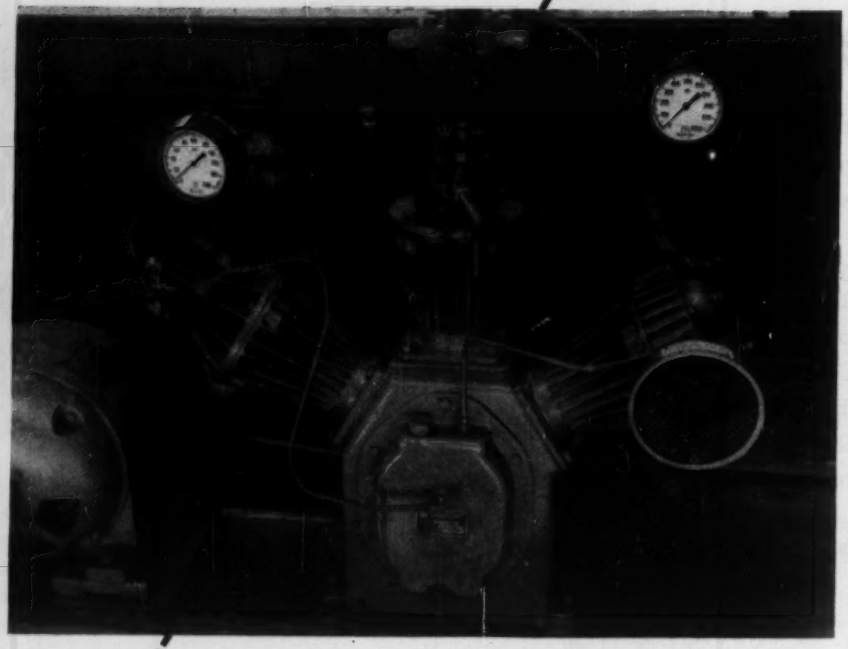
Telechron Motors Are Now Being Used for:

- Stoker, Oil Burner and Temperature Controls
- Industrial Process and Cycling Timers
- Business Machinery
- Medical Devices
- Household Appliance Timers
- Musical Devices

Telechron
SYNCHRONOUS MOTORS

The first and favorite synchronous electric timing motor

Here's how HELICOID GAGES

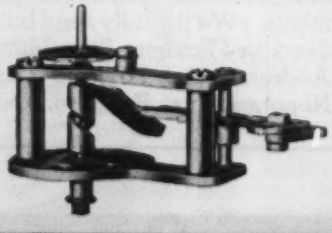


PAY OFF!

On a compressor like this, where you have vibration and rapid pressure pulsations, ordinary gages with clock gear movements last but a short time. Sometimes the gears are worn out in a few weeks.

By comparison, Helicoid gages wear for years. Actually, the gages shown here have been in service for 2½ years and are still going strong.

This is an example of the saving in maintenance which can be made by using Helicoid—the gage of enduring accuracy.



Only Helicoid gages have Helicoid movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

have come at a good time to enforce my belief that they must be used with caution in apparatus where failure of operation may subject a patient to trauma. Many of my designs are made to relieve a nurse of a tedious bit of work, but she must know that the apparatus is trustworthy or she will have to worry about both the patient *and* the apparatus. . . .

[Description and detailed discussion of one of the author's research projects omitted for lack of space. Is briefly described in list following this letter.—EDITOR]

Please do not think that physicians are not my friends. I am one, I have taught medical students, supervised medical officers, trained medical officers and Flight Surgeons in field duties, and I am working with one of the best groups I know of at present. The problem is rather to introduce methods of treatment into medicine for which the physician's training is not adapted.

Since the average physician has only one course of Physics before he enters medical school and none thereafter, you can see how he is handicapped in the use of Physics in his therapy. Yet some of my worst problems are with such men who want me to do everything with the aid of electronic devices. It may please you to know that I use mechanical clocks instead of relaxation oscillators, hydraulics instead of elaborate pumps and flow equipment, and when I have to use electrical thermostats I put them in series to open and parallel to close in multiples of three at slightly different temperature settings.

I am disturbed at the indifference of some people to the risks run by newborn babies in some of the incubator designs which have been sold.

I am enclosing a list of some of my projects and a reprint which I hope will suggest the new fields to be conquered by the use of accurately-controlled devices in therapy.

ARTHUR E. MACNEILL, M.I.
Research Associate in the Physiological Sciences, Dartmouth Medical School.

Enclosure No. 1

RESEARCH IN PLAN OR PROSPECT

1. [No instrument problem.—EDITOR]

2. Apparatus to warn of a wet bed, to avoid disturbing the sleeping patient, or for use with patients who lack sensation.

3. Apparatus for use on the postoperative patient to warn of changes in pulse rate, respiratory rate, and heart failure.

4. Development of transparent pressure dressings for the care of burns and skin grafts, using pneumatic or hydraulic means for maintenance of proper pressure.

5. Restudy of the Wangensteen type of stomach suction apparatus to avoid the dangers of constant suction and other unsatisfactory mechanisms of the present widely-used apparatus.

6. Design of a series of synthetic organ mechanisms. . . . the mechanical aspects of such problems are a direct extension of principles of therapeutic apparatus which I already have under consideration.

7. Preparation of a manual of clinical apparatus design. No such manual is now available, . . . The effects of suction on the capillary bed is an example of one of these common considerations.

[The other enclosure was a reprint of a description of an already-perfected drainage apparatus. Readers who can help Dr. MacNeill solve his measurement and automatic control problems will advance medical science by communicating with him. We trust that the good Doctor isn't prejudiced against electronic instruments. *We* are not. —EDITOR]

THEY never leave the ground in a Link trainer. All their "flying" is done blind, by instrument and "radio beam," and every movement of the controls is recorded. The recording device is powered by a Telechron synchronous electric motor.

Such an application is not unusual for these versatile motors. They have been used successfully in clocks, and timing and instrumentation devices for 25 years—and more. Every day Telechron *application engineers* are helping manufacturers adapt them to new and important uses.

Dependable, self-starting Telechron motors meet a wide variety of needs in electric devices—from the simplest switch to the most complicated control mechanism. They reach rated speed almost instantly and operate in perfect synchronism with any commercial frequency . . . *can't run faster or slower.* Torque ratings are conservative. Precision building and Telechron's exclusive sealed-in oiling system assure accurate service and long life.

With a Telechron motor you give your product the plus value of Telechron leadership. For over 25 years, Telechron has been the largest producer of synchronous electric motors. Every one is Underwriters Laboratories approved. Telechron *application engineers* will be glad to discuss your needs. Address Motor Advisory Service, Dept. B, Telechron Inc., Ashland, Massachusetts.

Telechron Motors Are Now Being Used for:

Stoker, Oil Burner and Temperature Controls
Industrial Process and Cycling Timers
Business Machinery
Medical Devices
Household Appliance Timers
Musical Devices

Telechron
SYNCHRONOUS MOTORS

The first and favorite synchronous electric timing motor

Nth DEGREE ACCURACY

...ONE INCH TO ONE MILE!

Precision Made Bourdon Gauge Tubing meets and beats most exacting requirements . . . performance tests.

Nth DEGREE LABORATORY CONTROL

"Precision Control" safeguards absolute accuracy of size of tube and wall thickness . . . plus the development of exact uniformity of the structure of the metal so essential to long life of pressure spring tubing.

Nth DEGREE HEAT TREATING

"Precision Control" in heat treating is achieved in exclusive bright annealing, atmospherically controlled furnaces. The precision exercised in attaining metallurgical specifications makes possible a tubing which is outstandingly high in fatigue resistance.

Nth DEGREE ACCURACY IN TESTING

"Precision Controlled" inspection carefully checks to the Nth degree every inch of tubing produced. Precision produces Bourdon Gauge Tubing to specifications with any non-ferrous metal. It is available in all bourdon shapes, in cut or random lengths. Obtainable on good delivery.

WHEN PRECISION COUNTS . . . COUNT ON PRECISION

Aluminum alloy instrument tubing to exact specifications . . . preformed tubing to suit your needs . . . Coaxitube—the metal shielded wire for a 1001 electronic uses. Write for complete catalog today.

PRECISION TUBE CO.

PRECISION

Factory: 3824-26-28 TERRACE STREET, PHILADELPHIA, PA.

BOURDON TUBE WORKING PRINCIPLE

CHARLES T. FLACHBARTH

Chief Engineer—Precision Tube Company

Bourdon Tubing functions in an interesting manner which, to our knowledge, has never been expressed in mathematical relationships that completely predict its behavior under pressure or vacuum. This does not mean that Bourdon gauges are inconsistent—indeed they are highly reliable when used within the pressure ranges they are built for. The absence of a complete analysis merely means that each new design must be thoroughly tested, and cannot be developed by calculations alone.

Persons newly confronted with Bourdon problems often do not understand why a curved tube tends to straighten out when pressure is applied. The pressure exerts a definite force, expressed in pounds per square inch. If the curved tube follows an arc of a circle, the inside path along one side of the tube is longer than a similar path diametrically opposite. Since one inner path is longer because of the curvature, that portion of the tube represents a greater area. The pressure, which is everywhere the same, contributes a greater force in the direction of greater area, which is along the side that follows the longer path. This force is in the direction to straighten the tube. Similarly, a vacuum tends to force the tube into a smaller arc. This much is simple to calculate for a known shape of Bourdon tubing, formed in a definite way.

The difficulty arises in attempting to predict what the effect of this force will be on a curved tube, with suitable end corrections. This requires a knowledge of the stiffness of the tube. Here the tubing manufacturer assumes a role of paramount importance. His responsibility is to furnish seamless tubing with constant wall thickness, consistent spring properties, and exact duplication when considered as a structural beam. In general, the materials which have the required high proportional limit are not the ones which are worked most readily. This has proved to be a realm which genuinely requires the fine finish, close tolerances, production control, and metallurgical "know-how" of the Precision Tube Company.

INSTRUMENT POINTER TUBING KITS NOW AVAILABLE

For some time, laboratories and instrument repair men have been faced with difficulty in obtaining small quantities of accurately drawn aluminum alloy pointer tubing made to the exacting metallurgical requirements of this application.

To meet this demand, the Precision Tube Company has introduced a kit which consists of 25 feet of any combination of the following sizes:

3-S ALLOY

.026"	O. D. × .0015"	Wall
.023"	O. D. × .0015"	Wall
.0155"	O. D. × .0015"	Wall
.023"	O. D. × .002"	Wall
.019"	O. D. × .002"	Wall
.0155"	O. D. × .002"	Wall

52-S ALLOY

.019"	O. D. × .0015"	Wall

The purchaser specifies whether he wishes all one size, or any combination of sizes, in convenient lengths to total 25 feet. Price of the kit is five dollars, which includes postage to any place in the United States.

One of the problems of instrument repairing has always been to match the inertia and mass of the original system. Availability of a stock of various pointer sizes from Precision at last makes this possible.

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

On Its Twentieth Anniversary, *Instruments* Honors Instruments

IT takes moral courage for the staff of a magazine to refrain from making its Twentieth Anniversary an occasion for horn-blowing. It is a fact, however, that since *Instruments*' first issue came out there have been tremendous advances in the fields to which it is devoted:

—in the useful *applications* of instruments, meters, automatic controllers, inspection and testing devices, etc., throughout industry;

—in their diversification, standardization and quality;

—in the formulation of the theories underlying proper selection and correct application of these products;

—in "the recognition of Instrumentation as a science, as a distinct branch of engineering and as a distinct field of scientific management"—even by some groups jealously antagonistic in the past (but now climbing on the bandwagon);

—in the publication of *authoritative* texts on the several distinct branches of Instrumentation;

—in the organization and management of *instrument departments;*

—in the training of instrument apprentices, in the education of instrument engineers, etc.;

—in the influence and standing of instrument men;

—in the economic status of all instrument men, from young instrument apprentices to instrument-minded high executives whose titles do not include the word "instrument";

—and in the manifold blessings to civilization thereby brought about.

IN this age, the mere survival of an enterprise proves that it renders a service. Since the first ten years are harder than the second, *Instruments* at the end of 1937 had more reason for horn-blowing than it has today. Except that "tenth" has been changed to "twentieth," the foregoing is the editorial in the January 1938 *Instruments*.

That issue, of course, was a special one. It contained fourteen articles, each "A Decade of Progress in (Temperature, Pressure, etc.) Measurement and Control," each by an outstanding authority.

THIS Special Issue likewise chronicles progress but, instead of starting from the birthdate of *Instruments*, it starts from the birthdate of the United States of America.

However, this Special Issue is not a history but a "historical museum on paper" of American instruments in science and industry. Containing, as it does, a wealth of historical data, it risks being referred to as "a history." We fervently hope that no one will so refer to it; and we particularly beg reviewers not to do so in print. Just as there is an enormous difference between a mass of data (the raw material of science) and a science, so there is a difference between a mass of documents (the raw material of history) and a smooth piece of writing that deserves to be called a history.

SOME day a history of American instruments will be written. It should be a fascinating best-seller, rendering a great service to our industrial civilization; it might be a dull flop doing more harm than good. As a contribution to the proper preparation of such a history, this editorial introduction will recite many facts and circumstances. Another purpose of this introduction, however, is to make ALL readers enjoy this issue with keener zest—to read between the lines and discover the human interest, even the drama, that pervades the following pages.

* * *

But before we go into these details we wish, on behalf of all readers, to express deep appreciation of the tremendous amount of work done by the hundreds of contributors: Several specially-written manuscripts ran to more than 8,000 words—the length of a *Readers Digest* "condensed book." Even the one-page contributions represent, on the average, about two hours' work each. Tens of thousands of man-hours in hundreds of offices, laboratories, and plants have gone into making possible this Special Issue! Including the clerical work, the total may be a hundred thousand hours!

* * *

THE PLAN.—Bobby Burns was right when he wrote about "the best-laid plans of mice and men . . . " No finer plan could have been conceived than the one adopted last summer after careful deliberations by the publisher, the editor, and other discussers, who explored all possibilities. This plan consisted of two parts:

(1) The Twentieth Anniversary Issue to be a historical issue, chiefly of "FIRSTS"—in each case either the first instrument of its kind made in America, or the first commercially-produced model, or both. (In view of the modesty of many old-timers in the industry, the term "outstanding development" was used in addition to the word "firsts.")

(2) The issue to be made up entirely of pictures and captions mailed to *Instruments* by outside contributors; no historical delving or writing was to be done by the editor, because such work would take years instead of months.

THE INVITATIONS.—Various letters and advertisements were prepared last summer, in which the plan was outlined and the simple "rules" explained. These rules were all so obvious that no one would object to them—and nobody objected, but the great majority of contributions later received did not observe them. A typical announcement is printed in small type in the "box" on the next page. In all letters it had been stipulated that EACH description was to mention WHY the development was outstanding.

"EVERYBODY" INVITED.—The letters and other announcements were sent to a mailing list that has been built up in twenty years by The Instruments Publishing Company. This list includes all instrument manufacturers (as many as fifteen or twenty names for companies with branch factories) and during the war this list was expanded to include the instrument designers and makers in governmental and private institutions. Therefore it is the ideal list for sources of information on historically-important American instru-

ments. Moreover, thousands of persons not on this list received notification through the columns of the magazine *The Instrument Maker*. All in all, the coverage of sources of historical data was complete.

"HUMAN NATURE" FOILS PERFECT PLAN.—Contributions began to come in long before the November 15 dead-line; before mid-October they filled a file. Most of them consisted, believe it or not, of a brief letter of transmittal accompanied by a General Catalog or by a package of catalogs. The letter usually ran somewhat as follows:

All of our latest models are of historical importance; none should be left out of your Historical Issue. However, I'll be big-hearted and forgive you if you don't print pictures and descriptions of ALL of them. So please look over our entire line; pick out the items you want to include and send me a list of them: I'll then send you cuts or photographs. P.S. Submit your write-ups to me before you print them.

Another type of contribution found among the earliest received was the biography of an organization or of an individual, every date (birthdate, graduation from scientific school, changing business connection, etc., etc.) being submitted as meeting our requirements for historically-important developments.

In mid-October, therefore, a "personalized form letter" was sent to every name on the master list, in which the simple rules were re-stated. Brief extracts from this second letter:

Some of you have sent us a mass of booklets and asked us to pick out your historic achievements. Sorry, no can do!

YOU are the one to send us the pictures and to write the descriptions or narratives. We will not do any writing other than the editorial introduction.

Each contribution should be SIGNED. Each description should mention WHY the development was outstanding.

Some of you, who sent us photos and descriptions of new models just brought out, may believe that these new products are as "outstanding" as, the first thermometer made in America; but . . . please don't force us to assume the onerous role of censor.

To make a long story short: The total number of contributions could not even be counted because most of them were not usable, being the thousands of items in catalogs. To say that this raw material "filled a room" would be exaggerating—but it seemed to! Actually, it would fill an eight-foot bookshelf. Now then, dear reader—AND DEAR CONTRIBUTOR—what would you have done if you had been the editor? Would you have accepted everything and put out a January 1948 issue of *Instruments* the size of an eight-foot bookshelf? Of course not!

Together with the tremendous amount of raw material received from contributing companies and institutions, there are also two deplorable absences:

(1) The absence of truly historical material from some old-established companies, whose officials chose, for reasons of their own, to send us only descriptions of relatively recent outstanding developments;

(2) The absence of ANY contributions from certain companies which advertise in *Instruments* and otherwise display awareness of the value of cultivating the good-will of *Instruments* readers; the only explanation is that their officials deliberately "leaned backward" with extreme modesty. This, too, is an inevitable manifestation of human nature, as is shown for example when prizes and medals are awarded: on almost every such occasion, some winners refuse to attend the ceremonies and even refuse to accept the honors due them.

Many contributors sent specially-written descriptions and stated that we could have pictures IF we picked them out of catalogs and asked for them. We HAD requested pictures in ALL invitations, and we knew that our rising to this bait would be considered a promise to use the pictures, so we ignored the bait. Besides, it would have meant a needless waste of time.

Several contributors sent a number of dated descriptions plus a batch of photographs without identification—we had to use a magnifying glass to identify models and deduce years.

All contributors, of course, signed their letters of transmittal. A few signed the typewritten descriptions attached to their letters; the great majority did not—so we or an assistant wrote the signatures at the ends of the descriptions. (This was necessary, anyway.) In many cases—especially where one company appears under many dates—the signature is that of the official contributor although the descriptions may have been written by several engineers—even by engineers long dead.

We did not want to complicate matters by technicalities which fascinate professional historians like those who go through Lincoln's papers. We have, however, made one distinction—and one only. Here it is. In some cases, instead of the usual

John Smith, Wonder Widgets Co.

the reader will notice

J. J. Jones, for Great Gadgets Inc.

which simply means that Mr. Jones is a professional writer employed by a public-relations firm or an advertising agency and is not an executive of Great Gadgets Inc. To print the names of public-relations or other firms in addition to the names of the instrument manufacturers would not have served any useful purpose and would only confuse the reader, so we decided upon the three-letter word "for."

Now for an important "Public Notice": Your editor, and The Instruments Publishing Company, Inc., hereby disclaim responsibility for assertions of priority and this disclaimer is supported by irrefutable evidence in the shape of the original manuscripts. Careful as we were to preserve the original statements when re-writing lengthy descriptions, we were extra-careful in such cases of "firsts": WE DID NOT EDIT SUCH ASSERTIONS AT ALL. Where such wordings as "to the best of our knowledge" appear, they are the authors' own words—not your editor's words—and where

(Continued on page 88)

Historical Data Needed

"Pictorials" Preferred
but textual descriptions will be welcomed

Do you know about the first

mercury-in-glass thermometer	polariscope
prism spectroscope	watthour meter
compound microscope	laboratory balance
elastic-member pressure gage	micrometer
self-operating temperature controller	barometer
automatic voltage regulator	potentiometer
voltmeter and milliammeter	flow-rate meter
steam-engine governor	pneumatic controller
etc. etc. etc. etc. etc.	

made in America?

(either THE first, or the first "commercial")

If so, please write a BRIEF account for the Twentieth Anniversary Issue* of *Instruments*, attach a picture and send it to M. F. Behar, Editor, *Instruments*, 1117 Wolfendale St., Pittsburgh 12, Penna. This issue will of course feature the outstanding developments of the last twenty years but it will aim to be also the first concise history of American instruments.

*January 1948

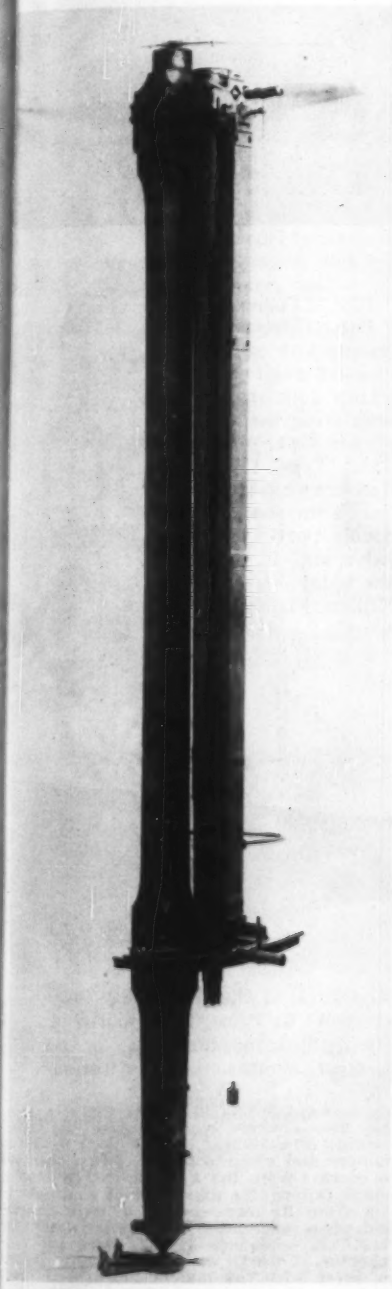
NOTES.—(1) Contributions will be arranged *chronologically;* each should be headed by the YEAR of its subject. (2) Each contribution should be signed, preferably by a veteran top executive. (3) One company or institution may send several descriptions, each headed by its year. (4) Dead-line: November 15, 1947, but please anticipate it . . . . Thank you!—MFB

Small-size reproduction of typical announcement

A "Historical Museum *on* Paper" *of* AMERICAN INSTRUMENTS

Please read the foregoing editorial explanation

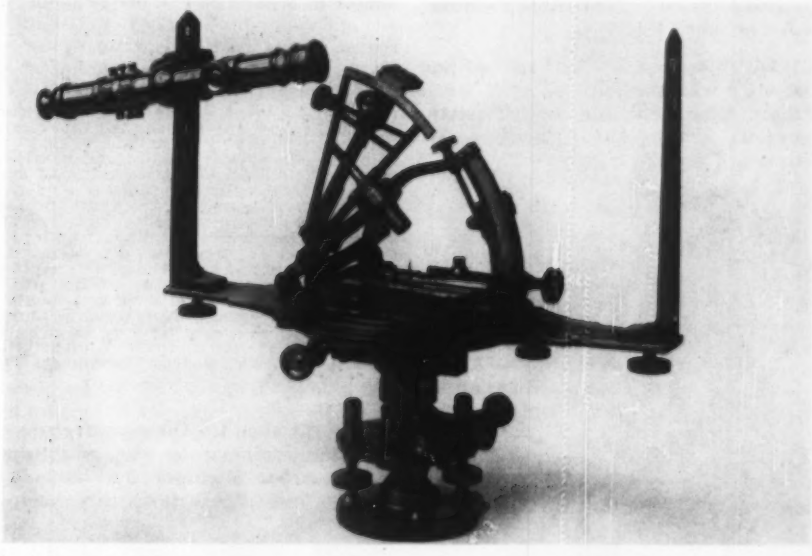
FIRST "GALLERY"
Eighteenth Century



c. 1784. "Zenith sector made at Philadelphia about 1784. It was used by Andrew Ellicott to determine the latitude of various points in the United States and was taken with him on the survey of the boundary between the United States and Florida, 1796 to 1800. Ellicott was Surveyor General of the United States in 1792 and, later, instructor in mathematics and engineering at West Point."—J. E. Graf, Smithsonian Institution.

SECOND "GALLERY"
Nineteenth Century *to* Dawn *of* Electric Power Age

1831. "... From Caesar Tagliabue of Como, Italy, who in 1769 was one of the first to make thermometers in appreciable quantities, consecutive generations moved to London, thence to Rio de Janeiro and finally in 1831 Giuseppe Tagliabue arrived in New York ... hung out his shingle on Water Street, later moving into the building at 238 Pearl Street. ... Giuseppe made many instruments besides thermometers."—George Terhune, C. J. Tagliabue Mfg. Co.



1836. "Solar compass. William Austin Burt of Michigan invented his solar compass for surveying mineral land in 1836. This is the form of the Burt compass made by W. & L. E. Gurley, Troy, N. Y., in latter part of 19th century."—J. E. Graf, Smithsonian Institution.

"1843 saw the establishment of the Eberbach Apothecary in Ann Arbor, Michigan, by Christian Eberbach. Out of it grew the laboratory apparatus and supply business now known as Eberbach & Son Company."—L. W. Bittman, Eberbach & Son Co.

1851. "The firm of Kendall & Taylor was founded in 1851."—C. S. Conner, Taylor Instrument Companies.

1859. "The Brown Instrument Co.'s founder, Edward Brown ... developed a workable pyrometer ... expansion type ... the first pyrometer to be manufactured in the U. S. In the years that followed ... won him recognition by the Franklin Institute and the award of the John Scott Medal."—C. C. Roberts, The Brown Instrument Co.

1862. "The first oil well in the United States was drilled by Drake in 1859. Three years later Tagliabue received a patent for its first oil tester."—George Terhune, C. J. Tagliabue Mfg. Co.

1864. "J. Arniboldi, an uncle of C. J. Tagliabue, made the Coal Oil Hydrometer which was adopted by the U. S. Petroleum Ass'n in 1864."—George Terhune, C. J. Tagliabue Mfg. Co.

1869. "General Anson Stager, formerly U. S. Superintendent of Military Communications, together with Elisha Gray, Physics professor of Oberlin College and Enos M. Barton, a telegrapher, established the apparatus manufacturing firm of Gray and Barton, progenitor of Western Electric."—Frank H. Lovette, Historian, Western Electric Co.

1870. "Pioneer devices for testing petroleum products were being developed by G. Saybolt, J. D. Rockefeller's personal adviser. ... Tagliabue worked closely with Saybolt ... and later ... received exclusive manufacturing rights ... instruments carry the identifying name of TAG-Saybolt."—George Terhune, C. J. Tagliabue Mfg. Co.

1872. "The name of the company was changed from Kendall & Taylor to Taylor Brothers. An ever-widening variety of instruments was being manufactured. An increasing number of workers acquired the requisite special skills."—C. S. Conner, Taylor Instrument Companies.

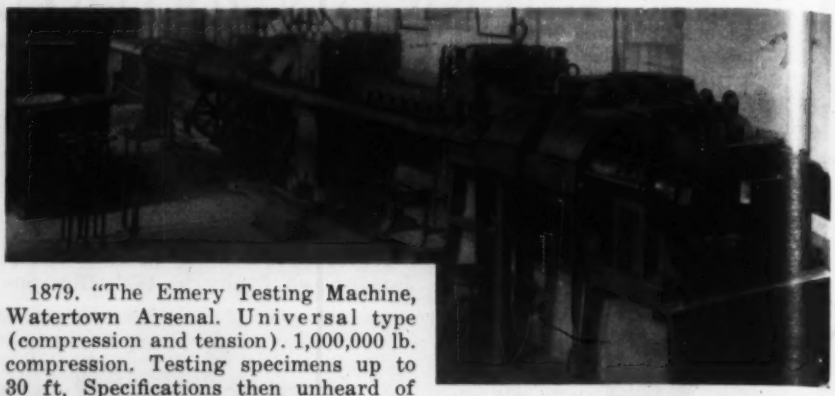
1874. "Giuseppe Tagliabue's son Charles duly served his apprenticeship. On March 19, 1874, at 53 Fulton St., New York, C. J. Tagliabue founded the company that still bears his name. . . . Scientists, explorers, doctors and inventors brought their problems. . . . It was in the development of industrial instruments that Giuseppe and Charles contributed so much . . ."—George Terhune, C. J. Tagliabue Mfg. Co.

1874. "The name Eberbach & Son Company was formally adopted when Ottmar Eberbach, son of Christian, joined the firm in Ann Arbor."—L. W. Bittman, Eberbach & Son Co.

1875. "B&L's first production microscope." — A. H. Blum, Bausch & Lomb Optical Co.

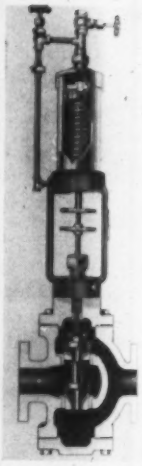
1876. "Western Electric Mfg. Co. won five first class gold medals and diplomas at the Centennial Exposition in Philadelphia. In this same year Elisha Gray, one of the co-founders of the Western Electric Co., was granted a patent on the first American system of multiple telegraph transmission by the separation of electrical frequencies. About this same time Gray invented the electric annunciator for elevators." — Frank H. Lovette, Historian, Western Electric Co.

1879. "The Emery Hydraulic Cell or Capsule has met many needs for measuring forces when standard commercial scales are not applicable. It has solved many weighing problems in the past 60 years in combination with either Bourdon gage type indicators or Tate-Emery air-jet-baffle Indicators. First application was load measurement on the Emery Testing Machine for the Watertown Arsenal. Applications now include dynamometers, propeller thrust, wind tunnel balances, weighing jacks, portable scales and many others in recent years. Capacities range from 10 to 1,000,000 lbs., with full load deflection usually less than 0.004". High natural frequency avoids resonance. In measuring vibratory loads, the mean value is given. Two or more cells may be added or removed when connected to a single Tate-Emery Indicator dial giving total load. These weighing systems are self-contained and portable, or built into users' equipment."—M. G. Van Voorhis, for Baldwin Locomotive Works.

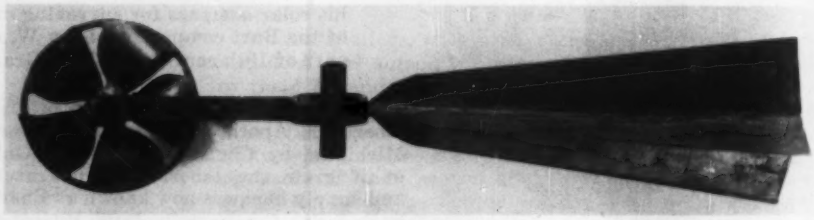


1879. "The Emery Testing Machine, Watertown Arsenal. Universal type (compression and tension). 1,000,000 lb. compression. Testing specimens up to 30 ft. Specifications then unheard of in their rigidity. In acceptance test, a forged link of hard wrought iron was broken at 722,800 lbs. and immediately afterward without adjustment, a horse-hair 0.007" in diameter was slowly strained and stretched 30% to break at an accurate indicated load of 1 lb. Two outstanding features of this famous machine are (1) the hydraulic diaphragm type Emery weighing cell or capsule for converting specimen load into hydraulic pressure and (2) flexure plates, taking the place of levers and knife-edges. The hydraulic capsule pressure-operated another smaller capsule of a sensitive lever and counterpoise weighing scale. This was the introduction of a hydraulic lever of large ratio (420,000 to 1) and entirely without frictional losses."—M. G. Van Voorhis, for The Baldwin Locomotive Works.

1880. "A shop for the manufacture of scientific instruments was established in Ann Arbor, Michigan, by Eberbach & Son Co."—L. W. Bittman, Eberbach & Son Co.



1881. "Fisher 'Type 1' Pump Governor represents the original idea of controlling pump discharge by regulating the flow of steam to the pump. This 'Type 1' Pump Governor introduced the semi-balanced double-ported control valve still in popular use today." — John J. Mullen, Fisher Governor Co.



1882. "Current Meter. This is the first form of the electrically indicating stream flow-rate meter devised by W. G. Price, U. S. Corps of Engineers, in 1882. It was used in stream flow measurements in the Mississippi and Ohio Rivers."—J. E. Graf, Smithsonian Institution.

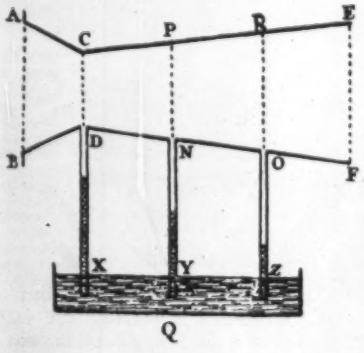
1884. Electric clocks. "Six years after Edison invented the electric light, Warner conceived the idea of moving the hands of a clock once a minute by means of an electromagnet. In his hand-made model a wet battery and switch caused the clock hands to advance by impulses. To automatize this operation he took an ordinary 60-beat pendulum clock and on the staff attached contacts that would close once a minute, and used this in place of his hand switch, so that the secondary clock hands advanced each minute. This was the first electric clock system and it started to revolutionize the clock industry. Warner called his enterprise The Standard Electric Time Co. The electric clock system of today consists of a 60-beat master clock with any number and size secondary clocks, designed to operate from the a-c. service. In case of power failure, the master clock continues to run from its own spring or weight drive and, upon resumption of the interrupter current, all secondary clocks (and program machine, if used) will automatically be set to agree with the master clock."—Herbert P. Blake, The Standard Electric Time Co.

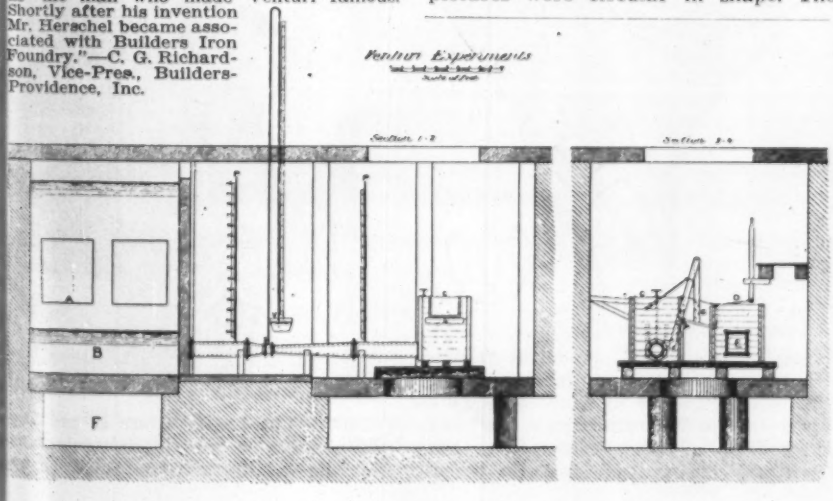
1885. Electric Program Machine. "Warner now decided his next step was to produce a device which would automatically ring bells at predetermined times, for schools and factories. His device consisted of a round paper disk mounted on a brass plate rotated by minute impulses from the master clock. This paper was ruled off into hours and minutes and small holes were punched at the times signals were to ring. Metal fingers rode on the disk and when they coincided with the holes the bells sounded. This was the first electric program machine. It underwent many complete changes in design and the modern type

today uses a plastic treated tape instead of the old paper disk."—Herbert P. Blake, The Standard Electric Time Co.

1885. Volumetric Dispenser. "... the world's first self-measuring pump which dispensed a controlled amount per pump stroke. In the original model these quantities were quart, half-gallon and gallon."—H. J. Slack, Bowser, Inc.

1886. Herschel's invention of the "Venturi" tube. "In 1643, Toricelli had announced that velocity of flow varies with square root of head. Late in the 1700's, Venturi had reported on 'Lateral Communication of Movement in Fluids' and his Plate I, here reproduced, bears a remarkable resemblance to the modern 'Venturi' tube but Venturi concluded only that fluids gain speed and lose head in converging pipe sections, and vice versa in diverging sections. Nature did not disclose to Venturi one of her greatest secrets. It was Clemens Herschel (b. Boston, 1842) who in 1886 conceived and designed the modern 'Venturi' tube and named the 'Venturi Meter.' The larger illustration is from his test reports in *Transactions Am. Soc. of Civil Engineers*, Vol. XVII, 1887. On Herschel's 86th birthday, Thaddeus Merriman characterized him as 'the man who made Venturi famous.' Shortly after his invention Mr. Herschel became associated with Builders Iron Foundry."—C. G. Richardson, Vice-Pres., Builders-Providence, Inc.



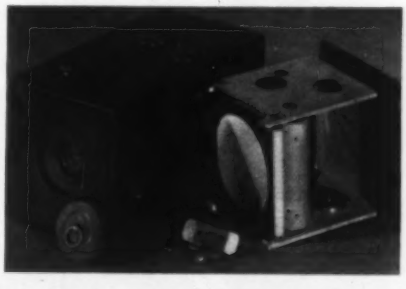


1887. Synchronometer Type Steam-engine Governor. ". . . to control the speed of looms, etc., used in the mills . . . the Conant Patented Steam-engine Regulator. The method of operation was similar to . . . regulating frequency in power lines at present. It consisted of a clock movement on one side and a ratchet on the other, the ratchet notching over one tooth every revolution of the engine. These two units were connected by means of a differential, and if the engine gained or lost speed, the differential would alter the opening of the throttle . . ."—R. S. Wilder, R. S. Wilder Inc.

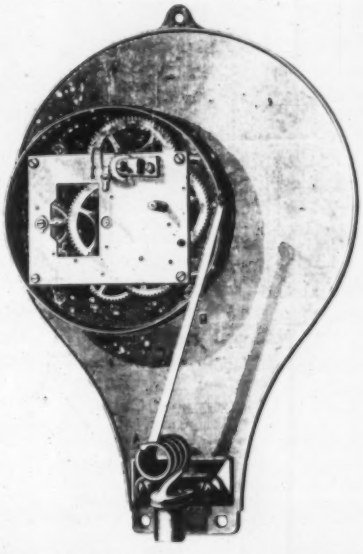
THIRD "GALLERY"

From Dawn *of* Electric Power Age *to* End *of* World War I

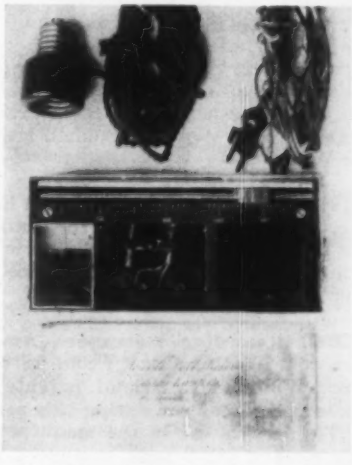
1888. "Model 1, Number 1. The first practical direct-reading electrical instrument, the 'Model 1' Voltmeter, was developed by Dr. Edward Weston and introduced to the then young electrical industry in 1888 . . ."—Philip Barnes, Weston Electric Instrument Corp.



1888. "The first Kodak. Loaded and unloaded at the factory, it held a roll of paper coated with a photographic emulsion sufficient for 100 exposures. The pictures were circular in shape. The user returned the camera to the factory for developing and printing his pictures."—R. W. Brown, Eastman Kodak Co.



1889. Recording Pressure Gages. "The Bristol Mfg. Co., a few years later to be named The Bristol Co., was founded to manufacture the inventions of William H. Bristol. One of the first products was a recording pressure gage equipped with an ingenious element, later known as a helical pressure element . . . could be used under rough plant conditions by men not accustomed to handling delicate measuring apparatus . . . marked the beginning of a new era for instruments . . . introduced into industry the idea and practical use of recording instruments as a means of maintaining closer control over plant processes."—G. P. Lonergan, The Bristol Co.



1890. "Howell Portable Voltmeter, No. 52. This instrument was invented by

John W. Howell and patented in 1890. It was made by the Edison Lamp Co., Newark, N. J." — J. E. Graf, Smithsonian Institution.

1890. "The firm of Taylor Brothers was incorporated as Taylor Brothers Co."—C. S. Conner, Taylor Instrument Companies.

1891. "The first commercial Venturi tube—a 36″ tube—was built." — C. G. Richardson, Vice-Pres., Builders-Providence, Inc.

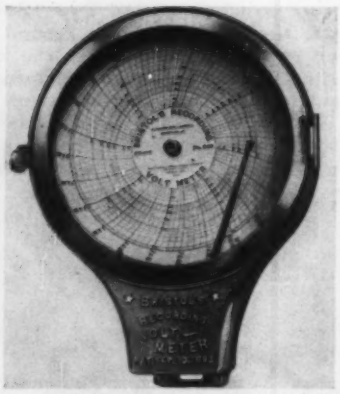
1892. "The Standard Cell. The first stable standard for the volt, the Weston Normal Cell, was developed by Dr. Edward Weston in 1892. The saturated form of this cell was adopted in 1908 as the International Standard of Electromotive Force."—Philip Barnes, Weston Electrical Instrument Corp.

1892. "B & L's 'Continental' microscope." — A. H. Blum, Bausch & Lomb Optical Co.

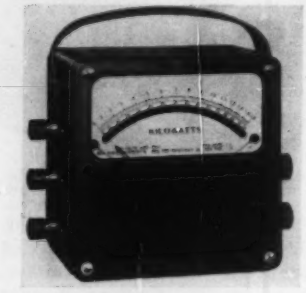
1892. Watch manufacture in the U. S. "Starting in 1892 we have made watches —instruments made for several hundred years. But all our efforts have been concentrated in making them better. This involved many 'firsts' in machines for processing parts—but those are not instruments."—Robert Waddell, Hamilton Watch Co.

1892. "W. R. Patterson, Western Electric, invented the die block for continuous sheathing of lead-covered cable."—Frank H. Lovette, Historian, Western Electric Co.

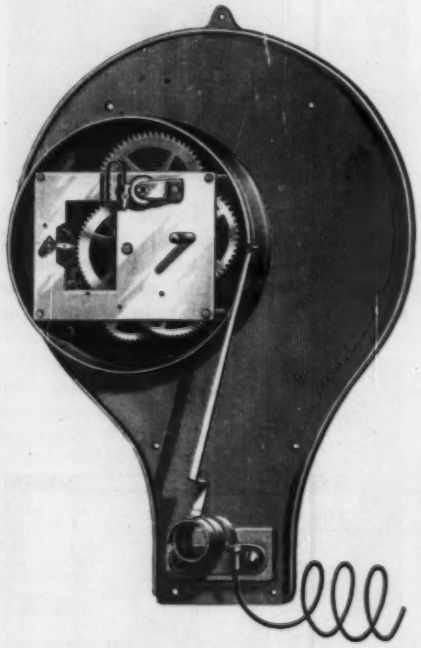
1893. Recording Voltmeters, Ammeters, and Wattmeters. "From 1890 to 1895, William H. Bristol patented a series of devices used during this period by The Bristol Co. in the manufacture of recording voltmeters, ammeters, and wattmeters. . . . At the Columbian Exposition in 1893, a Bristol Voltmeter



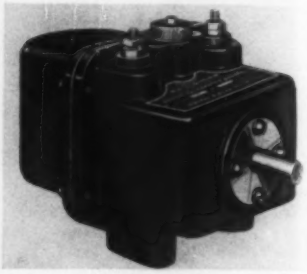
recorded the voltage on the Electricity Building."—G. P. Lonergan, The Bristol Co.



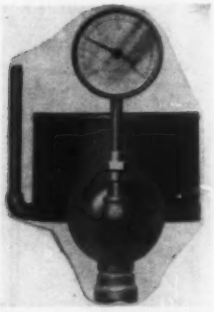
1893. "Electrodynamometer A-c. Instrument. Foreseeing the rapid commercial adoption of alternating current, Dr. Weston introduced a line of Deflecting Type Electrodynamometers giving direct, accurate measurements of a.c."—Philip Barnes, Weston Electrical Instrument Corp.



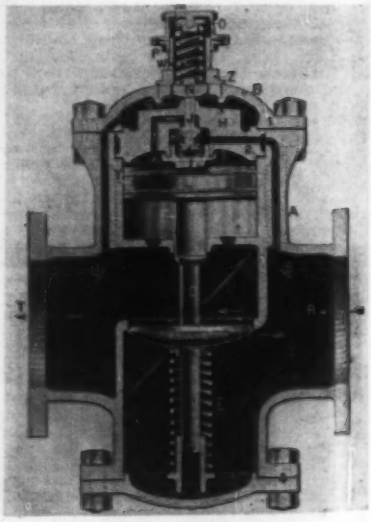
1893. Recording Thermometers. "The next important development by William H. Bristol was a temperature recorder utilizing a helical pressure element as used in the recording gage, . . . connected by capillary tubing to a temperature-sensitive bulb. It was to become known as the pressure-type or bulb-and-tubing type recording thermometer so widely used today." — G. P. Lonergan, The Bristol Co.



1896. "The Tachometer Generator. For a more accurate measurement of speeds in transportation and industrial equipment a small magneto generator was adapted from Dr. Weston's earlier dynamo, and combined with an indicating instrument. This tachometer generator provided electrical measurement of far greater precision and lower maintenance than previous mechanical devices."—Philip Barnes, Weston Electrical Instrument Corp.



1900. "TAG produced the first automatic pressure controller for industrial use. Its first application was in a large New York State chemical works, where several of them remained in satisfactory operation for nearly forty years."—George Terhune, C. J. Tagliabue Mfg. Co.

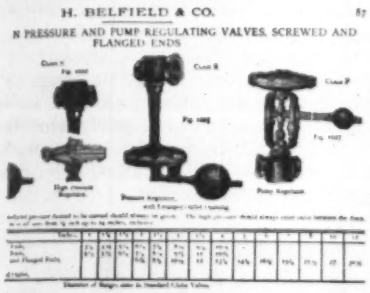


1900. "The Leslie 'Class E' pressure-reducing valve was introduced as the first dependable self-contained regula-

tor without a stuffing box, rubber diaphragm or dash-pot . . . a regulator with high accuracy of regulation and wide adjustable reduced pressure range without change of springs or diaphragm. It has since been used in principle by most manufacturers of this equipment." —John S. Leslie, Pres., Leslie Co.

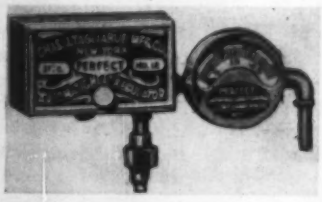
1900. "The Peat and Marl Sampler designed by Professor Davis of the U. S. Geographical Survey was first manufactured by Eberbach & Son Co."—L. W. Bittman, Eberbach & Son Co.

1902. Diaphragm-motor Valves. "Among the outstanding Belfield developments of that year was a group of diaphragm-operated pressure-reducing and -regulating valves, as illustrated on page 87 of the 14th edition of the Belfield catalog. The diaphragm-motor construction


H. BELFIELD & CO. 87

N PRESSURE AND PUMP REGULATING VALVES, SCREWED AND FLANGED ENDS

was new and unique at that time. The diaphragm inner plate consists of a number of special segments with integral pivots at each end. One pivot is supported at the lower diaphragm plate just underneath the diaphragm, while the other pivot is connected to a corresponding socket integrally with the stem. This construction gives a complete support of the diaphragm for high pressure service. As the pressure above the diaphragm increases the diaphragm and the diaphragm segments deflect together, actuating the valve stem and valve disc respectively. Belfield also developed at that time a valve body with an enlarged outlet opening to cover applications of high pressure-drop involving steam or gases to provide for the necessary expansion of the fluid on the downstream side. See Fig. 1025, the 'Class R' pressure regulator."—E. Wolff, Chief Engineer, H. Belfield Co.



1902. Air-operated Temperature Controller. "TAG introduced the 'Perfect' Temperature Regulator. This instrument controlled temperatures by operating a pneumatic diaphragm valve . . . thermostatic bulb and flexible armored connecting tube . . . originally used most extensively in vulcanizing operations in the rubber industry and for processing foods in canneries. Following the appearance of this controller, positive automatic control for process work swiftly became universal in one industry after another."—George Terhune, C. J. Tagliabue Mfg. Co.

1903. "Time of Operation Recorders. The users of Bristol recording gages, thermometers, voltmetters, and Am-

meters in the early days found, in many instances, that the time at which the variable changed was more important than the exact measurement itself and, from the beginning, these instruments were widely used as time-of-operation recorders. The time element in process control became so important that there was a marked demand for a special instrument . . . This demand was fulfilled in 1903 by the Bristol Time-of-Operation Recorder."— G. P. Lonergan, The Bristol Co.

1903. Electric-contact Type Automatic Temperature Controller. "The Bristol Co. developed a thermometer-thermostat and manufactured it in ranges up to 800°F. for automatically controlling temperatures in ovens, tanks, rooms, etc. This thermostat with electric contacts was, as far as we know, the first automatic temperature controller to be put on the market. It embodied the same basic principle that is used in the electrically-operated controller of today."—G. P. Lonergan, The Bristol Co.

1903. "Although the Esterline-Angus Co. has pioneered in many techniques of recording instruments since its founding in 1903, there have been no basic changes in the electrical measurement fundamentals which are employed in its recorders. These are the time-tested basic devices known since the research of Oersted and Ampere on electromagnetism early in the 19th Century. . . .Permanent-magnet moving coil measuring elements for d.c., and electrodynamometer elements for a.c., have always been used in Esterline-Angus Graphics. . . . Many outstanding features have been added in the past twenty years to make them easier to use, more versatile, more rugged and more accurate." — Don Brewer, Esterline-Angus Co.

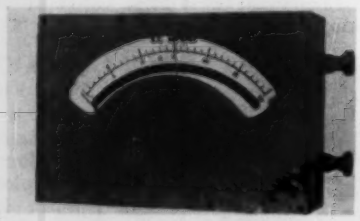
1903. "Bottomley, Paget and Hutton laid the foundation of the fused silica industry at Wallsend, England, utilizing for the first time pure glass sand fused in the electric furnace and shaped after withdrawal during cooling. The Thermal Syndicate, Ltd., formed as a result of this work, was the pioneer in the commercial application of non-transparent fused silica wares."—W. W. Winship, The Thermal Syndicate Ltd.

1904. Metallic Bellows. "The Fulton Company was organized to manufacture on a large scale the one-piece metal bellows invented by Weston M. Fulton, a weather forecaster in Knoxville, Tenn., who had become interested in studying atmospheric expansion. . . . The original bellows was made by curving a sheet of metal into a tube. The seam was soldered, and corrugations were forced into it. . . . Mr. Fulton took from the Norse legendary goddess of the atmosphere, Silph, his inspiration to name his product the 'Sylphon' Bellows."—J. R. Ruggles, Fulton-Sylphon Div., Robertshaw-Fulton Controls Co.

1904. "Electric Pyrometers. One of the revolutionary developments of William H. Bristol was the first practical electric pyrometer for industrial plant use, which was put on the market 1904. Previously, only delicate suspension-type electric pyrometers using costly rare-metal thermocouples were available. . . . Mr. Bristol's studies disclosed that while some heating processes in industry required a couple that would withstand 3000°F., nine tenths of pyrometer applications were on processes operating at below 2000°F. He designed an iron-constantan couple which developed about five times the emf. of the rare-metal couple, making possible the use of a rugged pivot-type millivoltmeter. The new electric py-

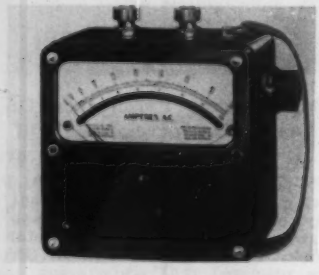
rometer, which, as far as we know, was the first to be built in this country, was reasonable in cost, could be permanently installed wherever needed in spite of vibration . . . and was in every way a practical success. . . . Mr. Bristol invented a simple automatic cold-end compensator that eliminated all of the hitherto intricate and bothersome methods. . . . These developments marked the starting point for wide use of pyrometers in industry. In the years that followed, thousands of Bristol Recording and Indicating Pyrometers were used in practically every industry."—G. P. Lonergan, The Bristol Co.

1904. "At the Louisiana Purchase Exposition held in St. Louis, Western Electric received a silver medal for the first mechanical repeater used in commercial telephony." — F. H. Lovette, Historian, Western Electric Co.



1905. "Laboratory Portable Instruments of yesterday and today provide an interesting contrast . . . The first Triplett moving-coil instrument is in decided contrast to the sleek modern design which characterizes today's products. . . ."—A. R. Baker, The Triplett Electrical Instrument Co.

1905. "Bowser built the world's first so-called 'filling station' for fueling automobiles, in fact, coined the name . . . The unit was equipped also with a hose which attached through the side of the cabinet for filling automobiles as well as having the ability to fill cans by controlling the valves."—H. J. Slack, Bowser, Inc.

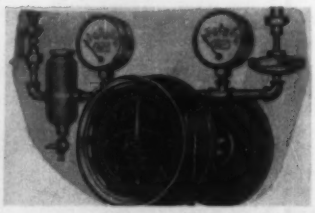


1905. "Movable Iron Type A-c. Instruments. Keeping a step ahead of the rapid conversion to alternating current, Weston anticipated the need for simple, inexpensive measuring instruments and in 1905 introduced a new line of movable iron type a-c. instruments." — Philip Barnes, Weston Electrical Instrument Corp.

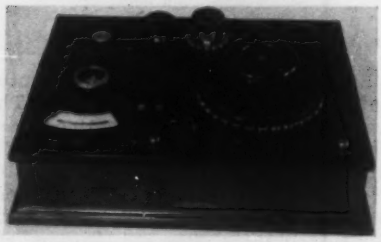
1905. "The Bodine brothers, Paul and Carl, foresaw the vast opportunities in the manufacture of small motors designed to fit many different applications. . . . the Bodine Electric Co. was founded. . . . became an important factor in instrument design."—W. M. Yogerst, Bodine Electric Co.

1905. Liquid-level Recorders. "The recording pressure gage principle [see 1889] was applied to a series of Bristol Liquid and Water Level Recorders for measuring the height of liquids in tanks and reservoirs. The basic principle is still used in many of the instruments built today for liquid-level measurement."—G. P. Lonergan, The Bristol Co.

1906. "First Type K Potentiometer. Instrument could be standardized without changing the scale setting, and could be switched quickly from one range to the other."—H. M. Parshall, Leeds & Northrup Co.

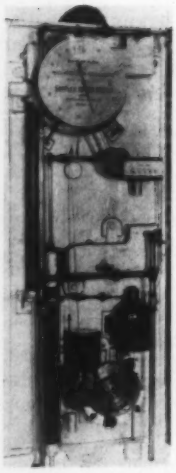


1906. [EDITOR'S NOTE.—The only caption on this photograph (received as we go to press) is the date "1906." The nameplate reads "Perfect Automatic Controller—Temperature or Pressure—C. J. Tagliabue Mfg. Co."]



1906. "The Deflection Potentiometer developed by Brooks at the NBS . . . requires only a preliminary balance with a single dial. The reading of this dial, combined with the deflection reading of a calibrated pointertype galvanometer with automatically adjusted sensitivity, yields an accuracy of better than 0.1%. . . . wide use in manufacture and rapid checking of precise instruments with direct reference to a standard cell."—Hugh Odishaw, National Bureau of Standards.

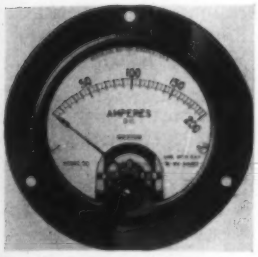
1907. "Western Electric made the first successful installation of telephone and selector equipment for train dispatching on the lines of the New York Central Railway."—F. H. Lovette, Historian, Western Electric Co.



1907. " . . . one of the oldest 'Frosts' . . . this early Simplex meter . . . remarkable for its time . . . measured from maximum flow to 1/15 of maximum with an error not exceeding 2% . . . two vertical steel tubes 2" ID to form the U-tube manometer . . . 44" mercury deflection of which 22" was utilized for float motion . . . Water clock, essentially a water wheel controlled by a pallet escapement . . . assured continued operation of the instrument without electric power or mechanical winding . . . recording chart [not shown] . . . 30-day movement . . . ½" per hour . . . passed over an inked pad and every two minutes a pin . . . perforated the paper . . . pin-hole edges were colored [ink pad] . . ."—R. A. McQuade, Simplex Valve & Meter Co.

1907. "Pyrometer Controllers. The first electric pyrometer controller was built by The Bristol Co. It was a millivoltmeter pyrometer equipped with electric contacts for operating fuel control apparatus. The first controllers were used in automatically controlling the temperature in soft metal melting pots and heat treating furnaces."—G. P. Lonergan, The Bristol Co.

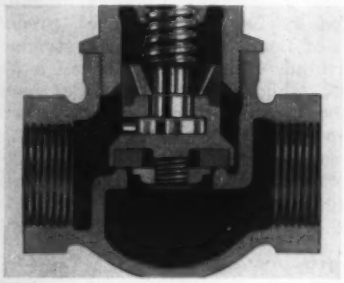
1907. "The name of this company was changed from Taylor Brothers Co. to Taylor Instrument Companies. Between 1890 and 1905 the following affiliations had been made: Hohmann & Maurer Mfg. Co. who manufactured industrial thermometers; Watertown Thermometer Co., manufacturers of weather instruments; the Davis & Roesch Mfg. Co., makers of temperature controllers; the R. Hoehn Co. of Brooklyn, and the American business of the Cambridge Scientific Instrument Co. Ltd., of Cambridge, England. In 1900 Short and Mason, Ltd., London, also affiliated; they were manufacturers of meteorological instruments . . ."—C. S. Conner, Taylor Instrument Companies.



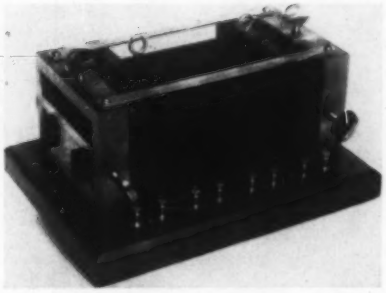
1908. "Panel Instruments. Manufacturers were beginning to include small switchboard panels on industrial electrical equipment. To provide the required compactness Weston introduced the Model 301 series, the first successful commercial reduction of precision instrument practice to small instrument size."—Philip Barnes, Weston Electrical Instrument Corp.

1908. "The Industrial Instrument Company (predecessor of The Foxboro Company) was organized in Connecticut, as sales company for its two subsidiaries, Standard Gauge Company, Syracuse, N. Y., and Standard Electric Time Company, Waterbury, Conn. Moved to Foxboro, Mass., during winter 1908-1909."—Robert Barton, The Foxboro Co.

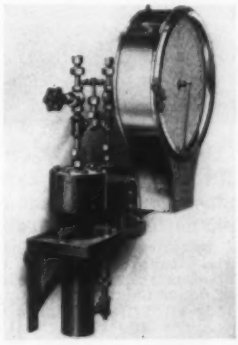
1909. "The Foxboro Co. acquired the assets of the American Instrument Co., Newark, N. J. Early developments of Industrial Instrument Company included: the first captive chart hub; the first pen lifter; stationary chart disk; interchangeable clocks; supported helical movement; round form case. Also, the improved pen-arm, quickly removable without tools; and the micrometer adjustment on the pen-arm bracket, in such manner as to provide adjustment at the center of motion, instead of half-way down the pen-arm."—Robert Barton, The Foxboro Co.



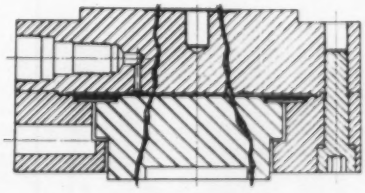
1909. "The H. Belfield Co. made another contribution to the development of control valves. . . . possible to repack valves in the fully-open position under prevailing pressure conditions . . . feature first incorporated in a hand control valve as shown by photograph. . . . The disk, in this case of composition type, has an additional seating surface which matches a corresponding seating surface in the valve bonnet. With the valve fully open, tight shut-off is assured as far as bonnet and stuffing box chamber is concerned. The operator can then repack the valve without shutting off the flow through the valve. This invention was subsequently patented by Belfield and the design was incorporated in later years in many automatic control valves . . . of considerable value to the operator . . . adopted by many manufacturers after the patent had expired. . . ."—E. Wolff, Chief Engineer, H. Belfield Co.



1909. "The Burrows Permeameter, developed at the NBS, was for several years the only generally accepted permeameter for standard tests for normal induction and hysteresis of magnetic materials."—Hugh Odishaw, National Bureau of Standards.



1909. "Recording Flowmeters. Bristol developed a recording mercury-float type flowmeter, the first to be built in this country. It was designed particularly for use with orifice plates and Pitot tubes for measuring and recording rate-of-flow of natural gas, steam, air, and liquids through pipes. It was the forerunner of the manometer flowmeter as we know it today."—G. P. Lonergan, The Bristol Co.



1909. "The first hydraulic support [see 1879, Emery testing machine; and 1879, Emery hydraulic capsule] had a diaphragm that bridged the gap between ring and column without auxiliary support. Because of diaphragm failures a bridge ring as shown was introduced across this gap for two Emery testing machines approved by Congress in 1909 for the Bureau of Standards. This ring serves to center and maintain central the column or 'piston' and to prevent diaphragm failures."—M. G. Van Voorhis, for The Baldwin Locomotive Works.

1909. "Herman Bacharach founded the Bacharach Industrial Instrument Co. Started manufacturing shortly afterward. Among products were low-pressure recorders for pressure and draft measurement; differential pressure recorders for measurement of gas and air flow."—J. A. Stein, Chief Engineer, Bacharach Industrial Instrument Co.

1909. "Foxboro's first dial-type Indicating Thermometer was made."—Robert Barton, The Foxboro Co.

c. 1909. "Richard P. Brown developed and patented an improved millivoltmeter recorder . . . one of the first recording pyrometers . . . remained in consistent use for many years, especially in the steel industry."—C. C. Roberts, The Brown Instrument Co.

1910. "Recording Thermometer . . . was among the early thermometers in the United States which measured temperature by a mercury-actuated system . . . came equipped with 10 feet of capillary tubing . . . and its range was from 200° to 700°F. The zero adjustment was made by a vertical post inside the case door."—C. S. Conner, Taylor Instrument Companies.

1910. "Tide Predicting Machine which analyzes data obtained by tidal recording devices located in the field and which will predict at such times in the future as is desired, the normal rise and fall of tide with the times of high and low water."—Rear Admiral L. O. Colbert, U.S. Coast and Geodetic Survey.

1910. "The first Multiple-Pen Recorder was developed; the first long-distance Recording Psychrometer was sold."—Robert Barton, The Foxboro Co.

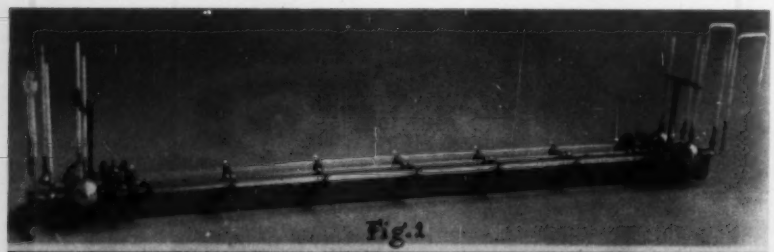
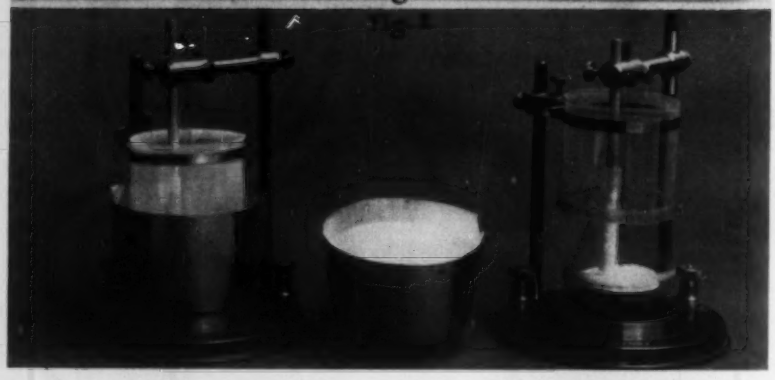


Fig. 1



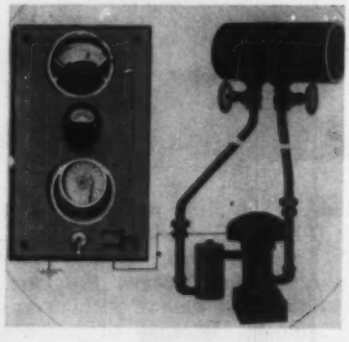
1910. "International Electrical Units. . . . British, French, German and American scientists meeting at the NBS completed the experiments which assigned mutually-consistent values to the standard cells and standard resistors used in their respective national standardizing laboratories . . . in terms of the resistivity of mercury and the electrochemical equivalent of silver. Fig. 1 shows the glass tube of known dimensions filled with mercury to form a standard 1-ohm resistor and Fig. 2 shows a voltameter in which the weight of silver deposited from a solution of $AgNO_3$ in a measured time served to measure the current. The units thus established formed the basis for all electrical measurements throughout the world for the following 37 years."—Hugh Odishaw, National Bureau of Standards.

1910. Maximum-registering Dynamometer. "The Hayes Dynamometer and Recorder developed in 1910 proved especially applicable to such testing machines as the Cross-breaking Machine, etc., also brought out by this company."—J. Burton Hayes, Hayes Scientific Appliances.

1910. Seamless Metallic Bellows. ". . . [see 1904]. In 1910 the bellows was made by drawing a seamless, thin-wall tube from a flat strip of brass. The tube was then corrugated and contracted until it would flexibly extend itself if an expanding vapor was formed in it by heat evaporating the liquid it contained. Some of our larger bellows, however, still contain a soldered seam."—J. R. Ruggles, Fulton-Sylphon Div.

1911. "Brief History of Bailey Meter Co.: Steam Flow-Air Flow Meter invented and developed by E. G. Bailey as a combustion guide. It aided boiler operators in maintaining the correct fuel-air ratio, thereby utilizing all available heat in the fuel. Mr. Bailey was at this time (1911) mechanical engineer and partner in the Fuel Testing Co., Boston, Mass. The first Steam Flow-Air Flow Meters were owned by the Fuel Testing Co. and installed on clients' boilers as part of the Company's service."—E. B. Bossart, Bailey Meter Co.

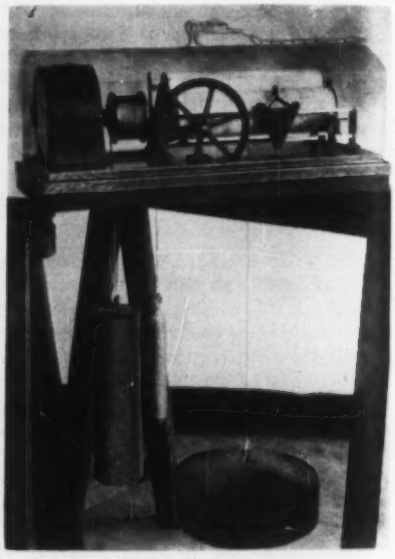
1911. "The L & N Ohmmeter was developed. This instrument was a Wheatstone Bridge which read directly in ohms, without any computations. It was designed for rapid, routine production testing of resistance."—H. M. Parshall, Leeds & Northrup Co.



1911. " . . . first successful introduction of such notable developments as the Electric Manometer (1911), Remote Reading Instruments (1911), Continuous Electrical Flow Integration (1911), . . . [see later years] . . . Original photograph of electrically-operated remote-reading flow meter . . . "—H. W. Stoetzel, Republic Flow Meters Co.

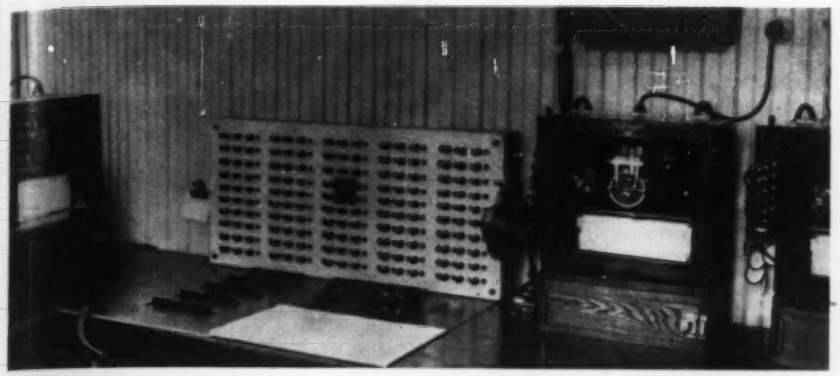
1911. "The Kraus-Jolly Balance was introduced by Eberbach & Son Co. It employs a recording principle, speeds up determination of specific gravities by eliminating several arithmetic steps."—L. W. Bittman, Eberbach & Son Co.

1911. "Foxboro's first Orifice Meter was developed. The upstream pressure was connected to the inside of a diaphragm spring, and the downstream pressure to the inside of the heavy cast-iron case. The motion of the diaphragm, to which a pen was attached, was a measurement of the differential . . . It was necessary to remove eight 1" bolts and a 200-lb. cover to change the chart. As the first major improvement, a spring-type differential gage was developed, with an enclosed pressure mechanism and external recording mechanism. This was used until 1914." [see 1914]—Robert Barton, The Foxboro Co.

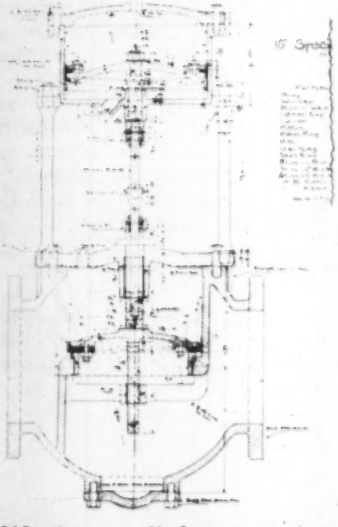


1911. "First 'Continuous Water Stage Recorder' designed and patented by J. C. Stevens in 1911; manufactured by Leupold & Volpel, predecessors of Leupold & Stevens Instruments, Portland, Oregon. . . . It had a 40-lb. clock weight; ran for three months without rewinding; recorded on a 10" strip chart 25 yards long—enough for a year's record; pencil reversed at both chart margins thus providing unlimited range of stage."—R. J. Stevens, Leupold & Stevens Instruments.

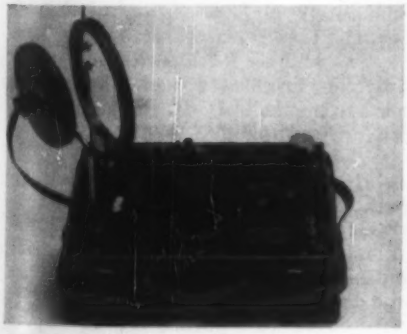
1912. "Western Electric purchased the Audion from Dr. Lee DeForest and within a few months Dr. H. D. Arnold of Western Electric's Engineering Dep't revised the circuits, obtained a higher vacuum and with these accomplishments developed the world's first high-vacuum tube. By 1914 the vacuum tube had been successfully developed to enable its use as a commercial telephone repeater. It therefore was feasible for the Bell System to complete the nation's first transcontinental telephone line during that year and early in 1915 the line was opened for commercial use with the vacuum-tube repeater."—F. H. Lovette, Historian, Western Electric Co.



1912. "First successful automatically-balanced recording instrument suitably rugged for industrial use—the 'Leeds Recorder' . . . performed mechanically all the operations which an instrument man would go through: . . . detected galvanometer unbalance, turned a sliderule until balance was obtained, and recorded the measured value. Even at this early date, equipped to standardize itself entirely automatically every 12 minutes. . . . Morris E. Leeds was awarded the Longstreth Medal by The Franklin Institute in 1920. . . . First installation . . . in a steel mill was made at The Midvale Co. [1912 photo] . . . for measuring furnace temperatures. The recorders had automatic standardizing of the potentiometer circuit, but correction for variations in cold junction temperature was manual [see 1915]."—H. M. Parshall, Leeds & Northrup Co.

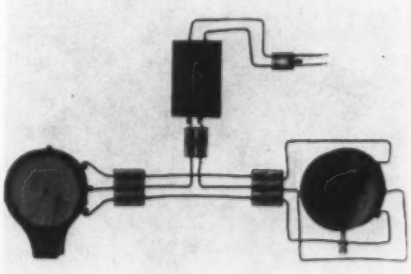


1912. ". . . cylinder-operated valve which is today, in improved form, one of Belfield's standard products. . . . purpose . . . to automatically refill storage tanks supplying railroad troughs."—E. Wolff, Chief Engineer, H. Belfield Co.



1912. "The Kolster Decremeter was . . . the first and only direct-reading instrument for measuring logarithmic decrement and wavelength, also the first of many radio devices developed at the Bureau to come into widespread use. . . . One operates the instrument by tuning to resonance and then detuning until the hot-wire ammeter scale reading is reduced to one-half. The decremeter scale, which may be rotated independently, is now set at zero, then clamped so that when the capacitor is again varied it will rotate with it. The capacitor is then tuned back through resonance and off on the other side of the resonance curve to half the reading at resonance. The scale reading now opposite the zero index mark is then the value of the decrement of the circuit being measured plus that of the (known) decrement of the decrement."—Hugh Odishaw, National Bureau of Standards.

1912. "The 'Foxboro' trademark was adopted."—P. C. Bunker, The Foxboro Co.

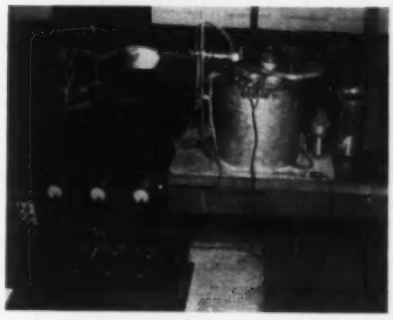


1913. Electric Telemetering. "Bristol's Long-Distance Transmitting and Recording System for remote measurement of pressure, liquid level, and temperature . . . operated on the induction balance principle. . . . exceedingly successful . . . widely used by city gas companies . . . industrial plants . . . water companies . . . "—G. P. Lonergan, The Bristol Co.

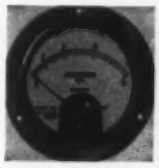
1913. "The first L&N precision calorimeter resistance thermometer . . . consisted of a carefully wound and aged platinum resistance element, in a protecting tube designed for fast temperature response."—H. M. Parshall, Leeds & Northrup Co.

1913. "Foxboro developed the first air-operated flapper nozzle type of temperature or pressure controller having a calibrated setting dial. It was an on-off type controller. (It operated on vacuum, but was soon changed to operate on air pressure.) The first recorded sale was in July, 1914."—Robert Barton, The Foxboro Co.

1914. " . . . introduction of TAG's basic patents on time-temperature and time-pressure controllers, the first in the industry."—George Terhune, C. J. Tagliabue Mfg. Co.



1914. "Bomb calorimeter and apparatus developed at the NBS for measurements of high precision."—Hugh Odishaw, National Bureau of Standards.



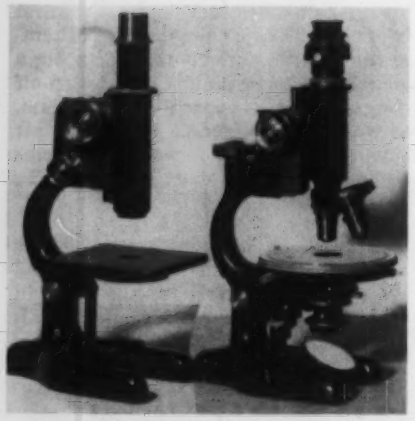
1914. "The Thermo-ammeter. During the First World War radio transmitters were being put into use employing currents of such high frequency that no ordinary ammeter could measure them. Weston solved this difficulty by introducing the thermo-ammeter, which measured these currents by use of a thermocouple."—Philip Barnes, Weston Electric Instrument Corp.

1914. Recording Mercury-float Type Flowmeter. "The mercury-float type differential gage was developed by Foxboro, in conjunction with T. H. Kerr, of the Ohio Fuel Supply Co. . . . Features, still inherent in Foxboro design, were the patented 'Pressure-Tite' bearing (with no stuffing box and no need for adjustment) and the mercury-submerged check floats to prevent overrange and mercury losses."—Robert Barton, The Foxboro Co.

1914. "The recording electric tachometer, consisting of a magneto and a recording voltmeter calibrated in units of speed of rotation or speed of travel, was developed by The Bristol Co."—G. P. Lonergan, The Bristol Co.

1914. "The Foxboro Company, incorporated in Massachusetts, took over the business of the Industrial Instrument Co., which was then dissolved."—Robert Barton, The Foxboro Co.

1914. [First airplane gyropilot. See 1932 for first mention.—EDITOR]



c. 1914. "Left, B&L laboratory microscope; right, B&L chemical microscope." —A. H. Blum, Bausch & Lomb Optical Co.

1915. "The first successful combination of an air-operated controller and a temperature or pressure recorder, known as the Recorder-Controller, was produced by Foxboro."—Robert Barton, The Foxboro Co.

1915. "First development by Leeds & Northrup of automatic reference-junction compensation for potentiometer recorders. . . . By using a nickel coil in a 'split' potentiometer circuit, variations in cold-junction temperature were automatically corrected, computations and adjustment of reading were eliminated . . .made it possible for industrial potentiometers to measure directly the actual temperature rather than temperature difference between hot and cold junctions, without need for continuous attention by human operators."—H. M. Parshall, Leeds & Northrup Co.

1915. "Foxboro introduced what was then called the 'inverted' recording mechanism, with the pen extending down from the top of the case (as is now generally standard) instead of extending up from the bottom."—Robert Barton, The Foxboro Co.

1915. "The Wentworth-Hunt Micrometer, an integrating recording micrometer stage for analysis of rocks or other crystalline materials, produced by Eberbach & Sons Co. after a design by Dr. C. K. Wentworth."—L. W. Bittman, Eberbach & Sons Co.

1915. Transoceanic Radiotelephony. "Using the vacuum tube [see 1912: DeForest and Arnold], Western Electric engineers were able to transmit the human voice from Arlington to the Eiffel Tower and from Arlington to Honolulu. Because of Dr. Arnold's vacuum tube Western Electric engineers immediately proceeded with the basic developments which later led to successful radio broadcasting, electric sound recording, successful public-address systems and commercial talking pictures."—F. H. Lovette, Historian, Western Electric Co.

1915. "The company was incorporated . . . Herman Bacharach as president and among officers L. J. Speidel, Prof. W. Trinks . . ."—J. A. Stein, Chief Engineer, Bacharach Industrial Instrument Co.

1916. "Brown Instrument Co. secured exclusive manufacturing rights to 'Heatmeter' developed jointly by P. D. Foote and T. R. Harrison (later to join Brown). Instrument . . . eliminated the dry cells previously necessary for millivoltmeter type pyrometers . . . unaffected by variations in length of leads, . . . combined advantages of millivoltmeter and potentiometer without the disadvantages of either. Consequently, the instrument was especially adaptable for central switchboard use involving the connection of a number of thermocouples located at various points to one instrument. This undoubtedly was a forerunner of the centralized panelboard so common in industry today."—C. C. Roberts, The Brown Instrument Co.

1916. "The first 'Thermo-Tyme' Regulator . . . The single-duty cam revolved by means of a clock movement and allowed the air valve block to move up or down, thereby regulating the amount of air to the diaphragm valve. Temperature control point changes were made by an adjusting post underneath the cam."—C. S. Conner, Taylor Instruments Companies.

1916. "The Mueller Bridge, a high-precision calorimeter bridge for temperature measurements by the resistance thermometer method, was developed by L&N in coöperation with Dr. Mueller of the NBS."—H. M. Parshall, Leeds & Northrup Co.

1916. Brooks Variable Inductor."This variable self and mutual-inductor . . . provides an astatic arrangement of pairs of inductance coils so shaped that for inductance readings the 180° scale is closely linear except at the ends. Such inductors are therefore extremely useful in a-c. bridge and measurement applications, and have been manufactured in large numbers."—Hugh Odishaw, National Bureau of Standards.

1916. "The Bristol Co. developed a Time-Temperature Controller which automatically carried a heating operation through a predetermined program of temperature changes."—G. P. Lonergan, The Bristol Co.

1916. "L&N developed the box-type reflecting galvanometer . . . good sensitivity with rugged construction and ease of manipulation."—H. M. Parshall, Leeds & Northrup Co.

1916. "Bailey Meter Co. was organized in Boston, Mass. to manufacture, sell and apply the Bailey Boiler Meter (Steam Flow-Air Flow) and other related metering equipment for the economical combustion of fuels and the efficient operation of steam plants . . . practically universal acceptance by operators of power boilers."—E. B. Bossart, Bailey Meter Co.

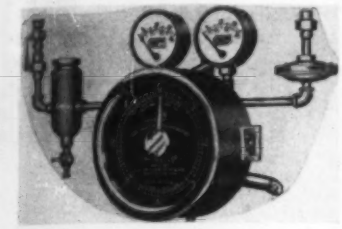
1916. "The L&N Kelvin Bridge . . . for measuring low resistances was completely self-contained and employed a variable low-resistance standard instead of a fixed standard. It was unusually easy to operate over its entire range." —H. M. Parshall, Leeds & Northrup Co.

1916. "E. C. Wente, Western Electric engineer, invented the Thermophone which enabled him to develop the electrostatic microphone a few months later. Both were officially adopted by the Bureau of International Reference in Paris."—F. H. Lovette, Historian, Western Electric Co.

1916. "The Macbeth Illuminometer . . . combined ease of operation with moderately high precision, so that it could be used for accurate lighting surveys as well as for a secondary standard for brightness and illumination measurements."—H. M. Parshall, Leeds & Northrup Co.

1916. "Richard P. Brown patented apparatus for determining and recording transformation point of steel . . . invaluable in heat treatment . . . positive indication of the points of recalescence and decalescence . . . two galvanometers connected to separate thermocouples, one inserted in a neutral body which has no transformation point within measured temperature range; the other in the work. . . . recorder shows a temperature rise until a transformation

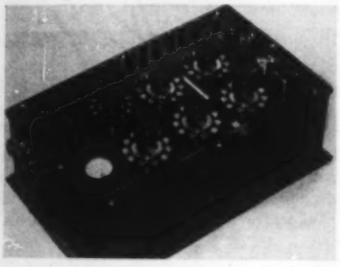
point is reached, at which time a sharp peak in the curve will occur. . . . "—C. C. Roberts, Brown Instrument Co.



1916. [EDITOR'S NOTE.—The only caption on this photograph (received as we go to press) is the date "1916." The nameplate reads "Peerless Temperature Controller Mfd. by C. J. Tagliabue Mfg. Co."]

1916. "Signalling equipment was added to L&N recording pyrometers. Early practice . . . an operator in a central control room watched instrument readings and, by switching on red, green and white lights near the furnace, signalled to the furnace operator that temperature was above, below, or at the desired point. Later in this year, a set of contacts was included in the pyrometer which automatically energized the furnace operator's signal lights. A remote indicating deviation meter near the lights was often used to show the operator how far the temperature was off the desired value."—H. M. Parshall, Leeds & Northrup Co.

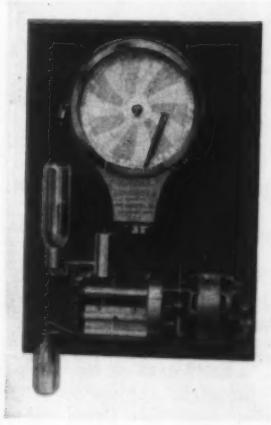
1917. "G. A. Campbell, Western Electric engineer, granted patents for wave filters to select currents on a basis of their frequencies."—F. H. Lovette, Historian, Western Electric Co.



1917. "The Mueller Bridge. Equal-arm Wheatstone bridges were developed by E. F. Mueller of the NBS for precision instruments of temperature with platinum resistance thermometers. The circuits of this bridge were so designed that the uncertainty of resistance measurements is only a few millionths of an ohm, making possible temperature measurements to a precision of 0.0001°C."—Hugh Odishaw, National Bureau of Standards.

1917. "Western Electric developed the first aircraft radio telephone and demonstrated it successfully between plane and ground for Army engineers on August 19th."—F. H. Lovette, Historian, Western Electric Co.

"1914-1918.— . . . During The First World War Foxboro was called upon to produce . . . thousands of gages, a large proportion of them being temperature, pressure and air-speed indicators for military aircraft of the U. S. and its Allies. Following the War, Foxboro took the lead in offering to industry gages equal in workmanship and accuracy to those specified in Government purchasing . . . Foxboro gages introduced the clear-cut numerals and the straight-line pointer on indicators, in place of the previously standard gingerbread pointers."—Robert Barton, The Foxboro Co.



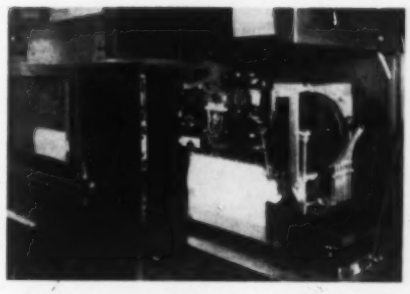
1914-1918. "During World War I, The Bristol Co. developed instrument equipment for the Army and Navy. Among outstanding developments . . . air-speed indicators, recording tachometers and recording thermometers for airplanes; ballast gages and hydrogen leak detectors for dirigibles; gasoline level indicators; and bulkhead door switches for naval vessels. In addition, a great many new instruments for industry. Many improvements . . . The electrolysis recorder, . . . and humidity recorders (illustrated) were developed during this period."—G. P. Lonergan, The Bristol Co.

1914-1918. "First World War . . . Richard P. Brown developed and introduced one of the first automatic temperature control pyrometer systems . . . utilized a millivoltmeter type instrument as the recording controller . . . When exhibited by Brown in England, it won instant attention as nothing like it had ever been seen in that part of the world."—C. C. Roberts, The Brown Instrument Co.

1918. "Precision gage blocks developed by NBS . . . mechanically lapped by the Hoke process, (also a Bureau development), are extensively used for calibrating instruments and checking limit gages."—Hugh Odishaw, National Bureau of Standards.

1918. "Bell System engineers established carrier telephony on a commercial basis between Baltimore and Pittsburgh." — F. H. Lovette, Historian, Western Electric Co.

1918. "The world's first laboratory for testing aircraft engine performance under high-altitude temperatures and pressures was constructed at the NBS early in 1918."—Hugh Odishaw, National Bureau of Standards.



1918. "First L&N installation of automatic control . . . either a motor-operated or solenoid valve. Program-type control using a cam system (illustrated) was also begun . . ."—H. M. Parshall, Leeds & Northrup Co.

1918. "The Rawson Electrical Instrument Company was formed . . . proceeded to develop a considerable variety of instruments, most of them now available for the first time in this country. Previous to this, most laboratory instruments manufactured were limited to from 100 to 200 μa. or higher full-scale. Rawson meters were soon being built with full-scale currents of 5 μa. or less, and a semi-suspended type gave full-scale deflection for 0.5 μa. Many of these early instruments are still in regular service after nearly 30 years of use."—A. J. Lush, President, Rawson Electrical Instrument Co.

1918. "First commercial 'disappearing-filament' type of optical pyrometer . . . first industrial temperature indicator of the same basic type as that used to define the International Temperature Scale above the gold point (1063°C.) . . . soon became standard for measuring high temperatures in steel mills, ceramic plants and other industries."—H. M. Parshall, Leeds & Northrup Co.

1918. "The British subsidiary of Western Electric demonstrated the 'Nash Fish,' a submarine detector, for which its inventor G. Howard Nash was decorated by the British Government." — F. H. Lovette, Historian, Western Electric Co.

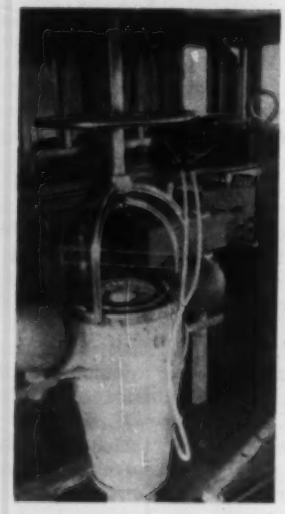
1918. "A selective L&N controller . . . shifted the basis of control from a thermocouple in one zone to a thermocouple in another, or from a couple in the combustion chamber to one in the work space. Essentially . . . technique widely used today, for example, in soaking pits." — H. M. Parshall, Leeds & Northrup Co.

FOURTH "GALLERY"

From *the* End *of the* First World War *to* Electronics *in* Industry

1919. "The White Potentiometer developed in collaboration with Dr. White of the Geophysical Laboratory . . . really high precision for the measurement of thermocouple temperatures, provisions for rapid measurement of two voltages for comparison tests."—H. M. Parshall, Leeds & Northrup Co.

1919. "Name of Federal Screw Corp. (which had been incorporated in 1912) changed to Federal Products Corp. During World War I we had devoted our entire efforts to manufacturing gages. In 1919 we developed a sphygmomanometer, then an automobile cylinder gage. For the latter we required a dial indicator. The 'sphyg' was the start of the Federal Dial Indicator: we first built a dial indicator for our own inside-diameter gages; then we conceived the idea of a movement built as an individual unit instead of using the case proper for the bearings . . . better alignment . . . this construction (with improvements) is the one which we use today."—L. C. Tingley, Federal Products Corp.



1919. "The Marine Radio Direction Finder and Radio Beacon System . . . early contributions by NBS to safety of marine navigation . . . developed, installed and tested in coöperation with the Bureau of Lighthouses . . . now in general use by practically all ships and many pleasure craft."—Hugh Odishaw, National Bureau of Standards.

1919. "A discussion between Dr. Herbert A. Lubs, Bureau of Chemistry, Dep't. of Agriculture, and Frank L. LaMotte, a research chemist (Johns Hopkins and Wisconsin) gave birth to a simplified and accurate application of colorimetric pH method for determination of acidity and alkalinity . . . the first pH testing set was developed, a simple rugged little kit which replaced both untutored guesswork and time-consuming laboratory testing."—S. M. McKenney, LaMotte Chemical Products Co.

1919. "Factory and main office moved to Cleveland, Ohio."—. B. Bossart, Bailey Meter Co.

1920. "The 'Normax' line of precision glass volumetric apparatus was established. Prior to this time, other firms had supplied ware made according to National Bureau of Standards requirements but not in large quantities."—J. J. Moran, Kimble Glass.

1920. "Improved graduating machines were developed."—J. Burton Hayes, Hayes Scientific Appliances.

1920. "Federal Top and Bottom Plate Movement . . . a basic design which has defied all attempts to improve upon." — I. A. Hunt, Federal Products Corp.

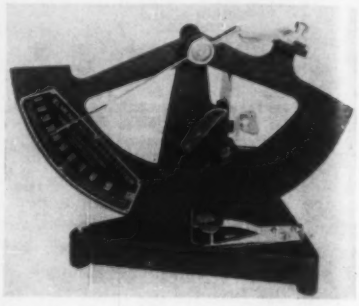
1920. "The 'Type T' Test Set, first of a line made by L&N for trouble-shooting on communications circuits, was developed for the telephone companies. This set could be set up for the various loop tests simply by throwing a switch; gave fast measurements and easy computations."—H. M. Parshall, Leeds & Northrup Co.

1920. "Bristol Electric Motor Valves . . . in connection with . . . automatic controllers . . . The combination units were designed to maintain correct proportion of air to gas and air to oil for complete combustion on both high and low flame settings. At about this time, . . . safety stop valve . . . to automatically shut off the flow of fuel to furnaces and ovens when either the power or air supply was interrupted."—G. P. Lonergan, The Bristol Co.

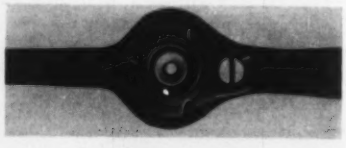
1920. "Western Electric established its Philadelphia instrument shop for the manufacture of radio equipment and intricate telephone testing instruments."—F. H. Lovette, Historian, Western Electric Co.

1921. "Foxboro was the first to publish complete information on gas coefficients for the orifice meter, in the form of a book, *The Orifice Mete* , by Brown and Hall, copyrighted in 921. This was followed by more com lete publications, covering liquid and s am flow measurement." — Robert Ba ton, The Foxboro Co.

1921. "A Canadian subsidiary, B iley Meter Co. Ltd., was formed with h ad-quarters at Montreal."—E. B. Bos art, Bailey Meter Co.



1921. "The Thwing-Albert Elmendorf Tearing Tester developed to replace human judgment in measuring of the force necessary to tear paper and similar sheet materials, using the gravity as a driving force, so that results are comparable the world over. Accepted as a standard by A.S.T.M. and T.A.P.P.I." —F. W. Eitzel, Thwing-Albert Instrument Co.



1921. "Ashcroft Gages and American Dial Thermometers were the first to be equipped with micrometer adjustable pointers to provide for easy adjustment without the necessity of removing the pointers from the shaft . . . readily accessible from the front of the instrument, regardless of how it is mounted." —S. Goodwin, Manning, Maxwell & Moore.

1921. The Aircraft Radio Range. "The equisignal radio range, now in general use by all commercial airline pilots, was first set up and tested in the U. S. in 1921. (Some work had been done in Germany several years before.) The photograph shows the original dual-coil antenna system used at the NBS to produce the on-course equi-signal zone in space. In the first tests the letter A was transmitted from one coil antenna and the letter T from the other. The pilot followed a course in space where the A and T signals were received with equal intensity. Today, A and N are interlocked to form a dash as the on-course signal. . . . No equipment other than an ordinary radio receiver is necessary on the plane."—Hugh Odishaw, National Bureau of Standards.

1921. "Temperature-time controller . . . instrument was redesigned . . . improved type of cam construction was featured. In addition, time-cycle adjustment provisions were made, interchangeability of parts was emphasized. . . ."—C. S. Conner, Taylor Instrument Companies.

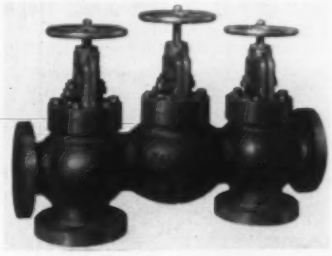
1921. "Multi-Pointer Gage introduced . . . the first instrument to indicate more than three related drafts and pressures on adjoining scales so that they could be easily compared."—E. B. Bossart, Bailey Meter Co.

1922. Precursor of Radar. "The first use of a radio method to detect moving targets . . . was done (by the Navy) by the 'Doppler-effect' as early as 1922."—M. E. Jansson, Technical Information Officer, Naval Research Laboratory.

1922. Radio Tubechecker. "In the early days of radio, tube buying was a gamble since a radio shop rarely had means for adequate tube checking. Weston removed this hazard when it introduced the portable tubechecker, an inexpensive device for quick, visible indication of tube values."—Philip Barnes, Weston Electrical Instrument Corp.

1922. "Foxboro brought out its cam-operated Time-Temperature Control system. This was followed by an Elapsed Time-Temperature Controller, in 1925."—Robert Barton, The Foxboro Co.

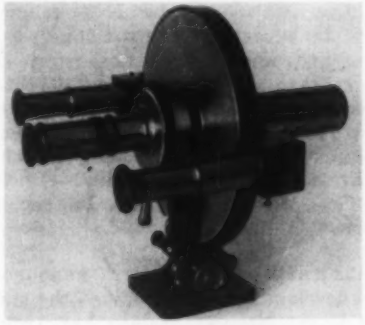
1922. "A method of investigating gaseous explosive reactions developed at the NBS in 1922 used a soap bubble as a transparent spherical bomb of constant pressure. The bubble, filled with a homogeneous gaseous mixture, was ignited at the center with a spark . . . the travel of the flame was recorded on a rotating film through a horizontal slot. Such records give the velocity of the flame in space and the expansion ratio. From these values the speed of flame relative to the unburned gases can be computed."—Hugh Odishaw, National Bureau of Standards.



1922. "Belfield originated the highly-specialized Schaefer By-Pass . . . more compact arrangement than the old method of using three valves together with an assortment of nipples, fittings, unions and piping . . . saved time and expense . . . eliminated from 8 to 14 threaded joints . . . The two outside valves are of 3-way type; center valve is of single-seated horizontal-through type. Outside valves are equivalent of the block-out valve used in connection with diaphragm-motor control installations; center valve is equivalent to manual control valve now installed in the by-pass line. . . : If the control valve is to be removed from the line, the flow through the bottom flange is shut off by means of the outside valves, permitting the controlled fluid to pass horizontally through the Schaefer By-Pass with the center valve becoming the manual controller."—E. Wolff, Chief Engineer, H. Belfield Co.

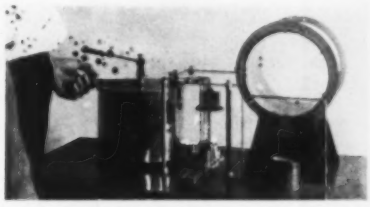
1922. "Bailey Feed Water Flow-Air Flow Meter installed on S.S. *President Harding*. First recording instrument installed on marine boiler."—E. B. Bossart, Bailey Meter Co.

1922. "We developed the 'D' and 'E' sizes of Dial Indicators which were unknown up to that time. Development of these sizes was due to our desire to give service to a certain customer who required a larger Indicator than our 'C' size."—I. A. Hunt, Federal Products Corp.



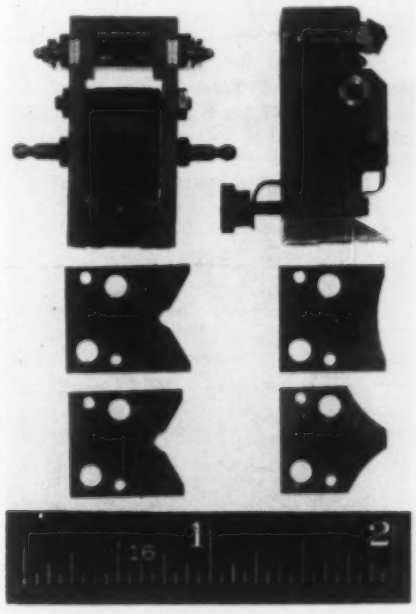
1922. "Polarimeter for the study of elliptically polarized light developed at the NBS. The half-shade analyzing nicol and the Brace half-shade elliptical polarizer and compensator system have been added to the elliptical analyzing system designed by Stokes for determining the ellipticity and locating the axes of elliptically polarized light. These additions to the Stokes instrument yield a precision of measurement that compares favorably with that of the best polarimetric measurements." — Hugh Odishaw, National Bureau of Standards.

1922. "In this year we started to apply Dial Indicators to various types of instruments which we felt would prove to be better than old conventional methods."—I. A. Hunt, Federal Products Corp.



1922. "In 1922 the primary standard of radio frequency was an absorption type *LC* resonator developed by the NBS. Frequency range of the instrument was 3.5 to 40 kc/s; precision was about 1 part in 5000. Calibration was in terms of standard electrically-driven tuning forks." — Hugh Odishaw, National Bureau of Standards.

1922. ". . . line of products expanded to include advanced designs of engine indicators, gas analyzers, temperature indicating and recording instruments . . ."—J. A. Stein, Chief Engineer, Bacharach Industrial Instrument Co.



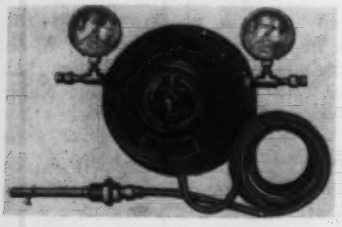
c. 1922. "The Tuckerman Optical Strain Gage, for measuring strain with a sensitivity of about one millionth of an inch per inch and accuracy of the order of 0.2%, was invented by Dr. L. B. Tuckerman at the NBS."—Hugh Odishaw, National Bureau of Standards.

1922. "Enactment of the Fordney Tariff Act gave protection to our infant industry and enabled it to grow to its present position. Before that time most

scientific instruments and supplies were imported. The ability of the scientific instrument industry to meet wartime needs stemmed from this protective tariff. In our considered opinion time and space could be well devoted to the importance of this Act."—L. W. Bittman, Eberbach & Son Co.

1923. "North and South American rights to sell and manufacture Johansson Gage Blocks were purchased by Ford Motor Co., Dearborn, Michigan." —O. E. Green, Johansson Div., Ford Motor Co.

1923. "Bailey Automatic Combustion Control placed in operation. This was the electrically-operated type. It was the first automatic method of maintaining optimum furnace conditions by using boiler instruments as indices."—E. B. Bossart, Bailey Meter Co.

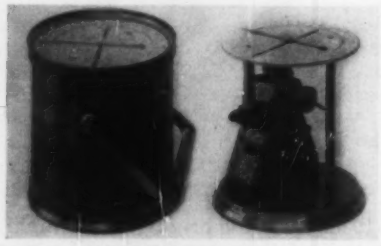


1923. "Controllers consisted of a capsular chamber which was an expanding member that controlled the opening and closing of an air valve." — C. S. Conner, Taylor Instrument Companies.

1923. "The 'B' size Dial Indicators were developed. Then designated as 'H' Indicators."—I. A. Hunt, Federal Products Corp.

1923. "Permutit began manufacturing the first 'Ranarex' instruments in the U. S. under special license agreements with the inventor of this CO_2 recorder. . . . Features which rapidly captured the interest of American industry were its sturdy construction, its continuous specific gravity operation which required no chemicals or water piping for aspirators or drain pipes for waste water, its enlarged dial and sweep indicator visible from many feet away, and its highly compact design and ease of attachment. These points, coupled with the fact that Ranarex could analyze CO_2 in any type of combustion gas with extreme accuracy and thereby save the plant operator up to 20% of his annual fuel costs, led to an increasingly wide demand for the product."—K. F. Urquhart, for The Permutit Co.

1923. "Republic introduced Voltage Compensation for Electric Reading Instruments."—H. W. Stoetzel, Republic Flow Meters Co.



1923. "This indicating decelerometer developed at the NBS was the first James Brake Inspection decelerometer used by many Police Departments for measuring stopping distances."—Hugh Odishaw, National Bureau of Standards.

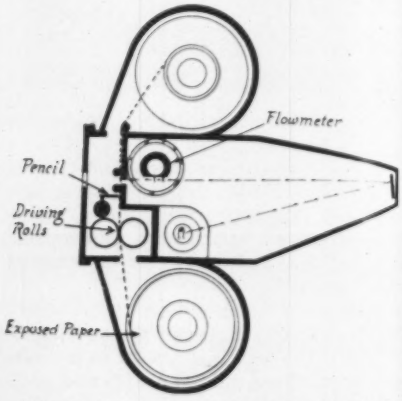
1923. "This recording decelerometer developed at the NBS provided the first automatically recorded data on the ability of an actual vehicle to stop and the factors involved in stopping." — Hugh Odishaw, National Bureau of Standards.

1923. Rectifier Type Instruments. ". . . broadcasting required supersensitive instruments for measuring extremely small voice currents. Weston was ready with the a.c.-to-d.c. 'rectifier' instrument, making it possible to measure much weaker alternating currents than otherwise possible."—Philip Barnes, Weston Electrical Instrument Corp.

1923. "Western Electric announced the development of Permalloy, the magnetic material destined to have great influence upon communications development, which was the product of ten years of research by W-E engineers."—F. H. Lovette, Historian, Western Electric Co.

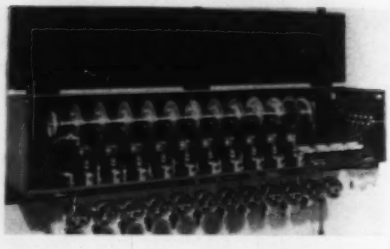
1923. "The first Kahn shaker used in the Kahn test for syphilis, made by Eberbach in coöperation with Dr. Reuben L. Kahn (Univ. of Michigan). The shaker completes a specified number of excursions of a given distance per minute."—L. W. Bittman, Eberbach & Son Co.

1923. "TAG developed and made the first automatic controller for processing in glass, the 'TAG Duplex Pressure-Temperature-Time Controller,' designed expressly for the Anchor Cap and Closure Co."—George Terhune, C. J. Tagliabue Mfg. Co.



1923. "Flow meter camera developed by the NBS for recording the rate of fuel flow in an automotive engine on the road." — Hugh Odishaw, National Bureau of Standards.

1924. Industrial Flow Controller. "Foxboro developed the first instrument for automatic control of flow, based on the principle of differential pressure measurement. This was the first satisfactory Flow Controller for industrial use."—Robert Barton, The Foxboro Co.



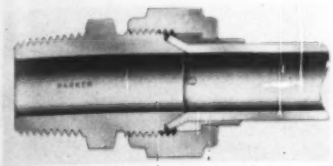
1924. "TAG introduced the first completely automatic process cycle controller, a multi-cam instrument, originally developed for tire presses in the rubber industry . . . models for many other process-control applications . . . outstanding success."—George Terhune, C. J. Tagliabue Div.

1924. "Western Electric developed the first commercially successful audiometer." — F. H. Lovette, Historian, Western Electric Co.

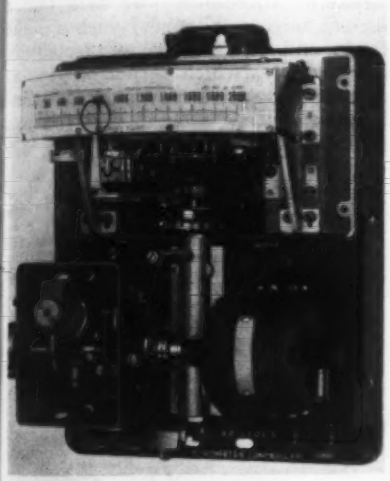
1924. "Accuracy of Johansson Gage Blocks increased from ten millionths inch a block up to one inch and for each inch of length on longer blocks to eight, four and two millionths inch."—O. E. Green, Johansson Div., Ford Motor Co.

1924. "Rotary movements were introduced in Ashcroft Gauges and American Dial Thermometers which for the first time made possible accurate, sim-

ple and quick adjustment in the field, and permitted the use of a one-piece link."—S. Goodwin, Manning, Maxwell & Moore.



1924. "Arthur L. Parker's flared type fitting for coupling metal tubing became the company's principal product . . . revolutionized the tubing industry . . . a boon in instrumentation installations." — S. E. Voran, Parker Appliance Co.



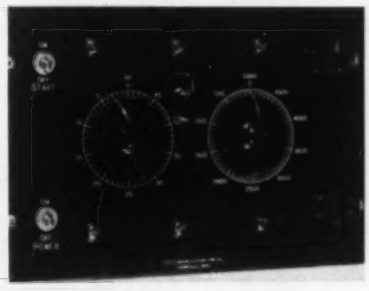
1924. "The Bristol Company had designed and put on the market the first automatic pyrometer controller in 1907. . . . In 1924, an extremely successful controller, the 'Model 479,' was designed . . . millivoltmeter-type measuring element, . . . control-circuit switching mechanism powered by an electric motor, . . . control was thus accomplished without interfering with the measuring system. . . . Thousands were built . . . Although manufacture was discontinued shortly after 1930, . . . many 'Model 479' controllers are still in successful operation."—G. P. Lonergan, The Bristol Co.

1924. "Among the most original and outstanding of our developments . . . In 1924: (1) Periodic Chart of the Atoms by Hubbard; (2) The tabulation of some 40 atomic properties and constants on the Mendeljeff table; (3) The Nuclear Transmutation Chart by Poole was the first tabulation of isotopes; (4) The Chart of Electromagnetic Radiations by Compton graphically displays the gamut of electromagnetic waves."—H. E. Brown, W. M. Welch Mfg. Co.

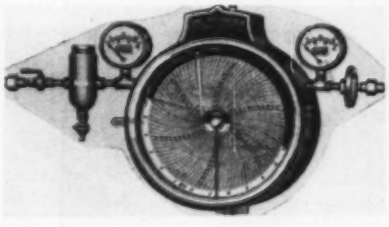
c. 1924. "One of the first specialized industrial instruments . . . the electrical indicating and recording CO_2 meter . . . indicate combustion conditions by comparison of the thermal conductivity of flue gases . . . a forerunner of many of the gas analyzers of the present day."—C. C. Roberts, Brown Instrument Co.

1921-1925. "Methods for the production in large quantities of high-quality volumetric glass apparatus were worked out."—J. J. Moran, Kimble Glass.

1925. The First Radar-principle Measurements Using a Pulse-echo Method. "In 1925 Doctors Breit and Tuve of the Carnegie Institution, working with radio engineers of NRL, used a pulse-echo transmitter and receiver to determine the height of the ionosphere."—M. E. Jansson, Technical Information Officer, Naval Research Laboratory.



1925. "Laboratory Time Standard . . . for the calibration of laboratory rotating standard watthour meters used by Central Stations . . . consists of: (1) A high-grade 60-beat master clock with electronic pick-up equipment; (2) A bench control unit (illustrated). The master clock . . . within 10 seconds per month. . . . The bench control unit consists of an impulse-operated mechanism, time selection dials, switches, [etc.] . . . circuit will automatically close then open for the selected period of time with an accuracy of 0.008 second."—H. P. Blake, Standard Electric Time Co.

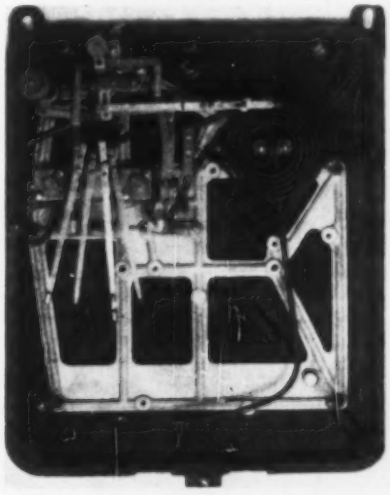


1925. "The first TAG combination recording and controlling instrument was perfected. It combined a recording thermometer mechanism and an air-operated controlling mechanism, both actuated by the same thermostatic system."—George Terhune, C. J. Tagliabue Div.

1925. "Our most outstanding achievement has been the introduction of Carl Zeiss and other optical measuring instruments to American industry in 1925. Any similar domestic-made equipment, either optical or mechanical, followed much later."—F. Koenig, George Scherr Co.

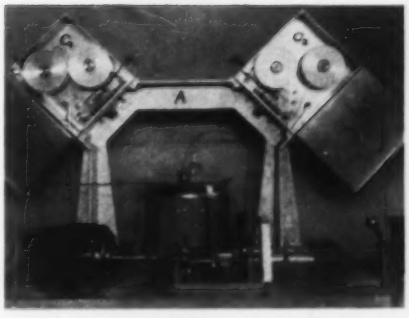
1925. "The Miller Kymographs for physiological work were developed by Ralph H. Miller of Eberbach & Son Co. . . . were among the first instruments of this type produced in the United States."—L. W. Bittman, Eberbach & Son Co.

1925. "German Rotameters first shipped to U. S. A. . . . High import cost limited their use on individual chemical operations."—H. W. Gripton, Schutte & Koerting Co.



1925. "Taylor introduced the '27R Series' controllers . . . employed a Bourdon spring whose movement was reduced and transmitted to the air valve through a system of linkages. The fulcrum of the valve-operating lever was carried on a movable bell crank which, with the definite temperature scale on the chart, provides the direct set feature."—C. S. Conner, Taylor Instrument Companies.

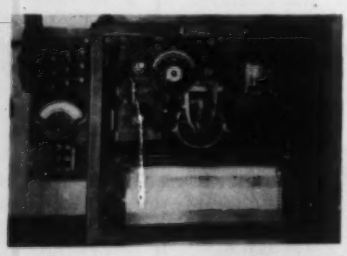
1925. "The Wizard Electric Counter . . . was the first unitized electrically-operated counter . . . operating speeds up to 600 counts per minute, low operating current, tremendous service life." — R. W. Allbright, for Production Instrument Co.



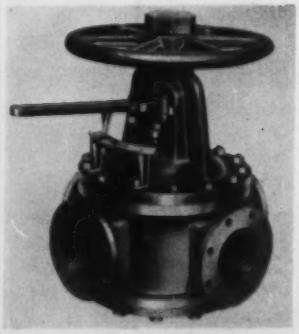
1925. "Dual camera developed at the National Bureau of Standards for photographing cloud chamber tracks simultaneously at right angles. Using 35-mm. movie film, the camera operates automatically in synchronism with the cloud chamber." — Hugh Odishaw, National Bureau of Standards.

1925. Spark Photography Applied to Ballistics. "Taken by a method developed at the NBS, this is a shadow photograph of a bullet after emergence from a barrel. Owing to refraction of light in passing through air which is compressed by the explosion of the propellant, such photographs also show the motions of the gases as well as the sound-wave phenomena accompanying projectile flight."—Hugh Odishaw, National Bureau of Standards.

1925. "The annealing of intricate shapes and relatively thin-walled apparatus was successfully accomplished in the mass production of this ware. (Previous methods either did not do a good annealing job or else took care of only a few pieces at a time.)"—J. J. Moran, Kimble Glass.



1925. "L&N installed in an Eastern utility the first comprehensive load telemetering system. Separate station loads were all telemetered to a central control panel, then added electrically to provide a record of system total load. . . ."—H. M. Parshall, Leeds & Northrup Co.



1925. "For many years Belfield had specialized in cocks of different types. 1925 saw further developments . . . automatic-control installations. Illustrated is a 6" 4-way cock of tapered plug design . . . plug itself is operated by a manual lever . . . large hand-wheel is to unseat and reseat the plug for ease of operation."—E. Wolff, Chief Engineer, H. Belfield Co.

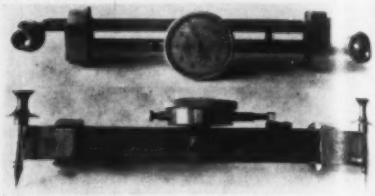
1925. "Brought out 'A' size Dial Indicator then known as 'Model 25,' and now called our "A6Q-2'."—I. A. Hunt, Federal Products Corp.

1925. "L&N introduced the first power frequency recorder combining high precision and high readability. This instrument was the first to employ the Wein Bridge for accurate power frequency recording."—H. M. Parshall, Leeds & Northrup Co.

1925. "Fused-on glass fillers were developed for Babcock test glassware. . . . These fillers replaced air-drying pastes of little or no resistance to chemical attack, solubility or abrasion."—J. J. Moran, Kimble Glass.

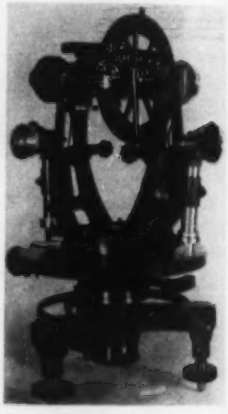
1926. "The Huggenberger Tensometer, sold in the U. S. by BLW, was one of the first . . . to make it possible to measure strains in the field as well as in the laboratory . . . accurate lever multiplication of strains."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1926. ". . . means by which solutions could be matched and the pH values read even though the solutions had some color or turbidity. Thus was born the original LaMotte Block Compara r, . . . pH readings, or those for chlori , etc. made by comparing and viewing t rough color fields of identical media. . . ."—S. M. McKenney, LaMotte Ch mica Products Co.



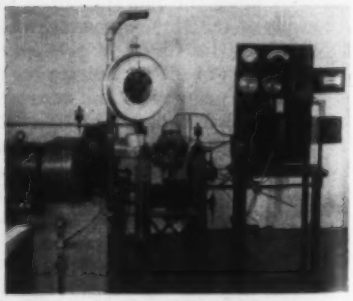
1926. "The Whittemore Strain Gage, licensed for manufacture by Baldwin . . . designed by H. L. Whittemore, National Bureau of Standards. Two bars (since changed to co-axial tubes) with a point at one end of each are connected by fulcrum plates which permit only axial movement. Relative movements are indicated on a dial."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1926. First Application of "Radio" or "Electronic" Principles to Continuous Measurements (of thickness and of moisture-content of fast-moving sheet materials, with remote reading and remote-control features) introduced in 1926. See under 1936 for first mention.—EDITOR.



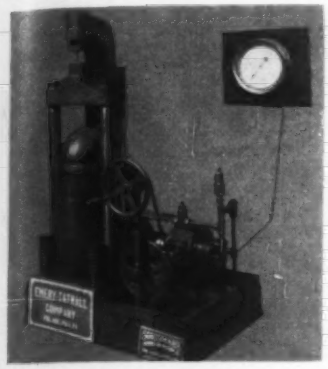
1926. "First-order Theodolite developed by the U. S. C&GS."—Rear-Admiral L. O. Colbert, Director, U. S. Coast and Geodetic Survey.

1926. "Bell Telephone Laboratories engineers measured the electro-magnetostriction of Permalloy to one part within a billion."—F. H. Lovette, Historian, Western Electric Co.

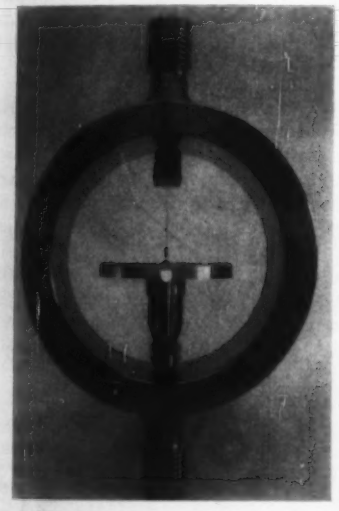


1926. "Testing machine developed at the NBS for obtaining basic data on the lubrication of journal bearings, including the effects of such factors as load, speed, bearing diameter and length, bearing clearance, oil viscosity and oil-inlet temperature and pressure, upon

the friction, load-carrying capacity and operating temperature of the bearings." —Hugh Odishaw, National Bureau of Standards.



1926. "The First Baldwin-Emery (then known as Southwark-Emery) Testing Machines. . . . for the first time in America an automatic direct-reading dial scale in materials testing machines. They retained the original Emery hydraulic cell [see 1879] and introduced high-precision Bourdon gages for load indication. . . . Usually three gages were incorporated to give three load ranges, and the dials were individually hand-graduated . . ."—M. G. Van Voorhis, for Baldwin Locomotive Works.



1926. "The proving ring for calibrating testing machines was developed at the NBS by H. L. Whittemore and S. N. Petrenko. It is an elastic ring equipped with a sensitive means for measuring its deflection under load. . . . Proving rings are manufactured in capacities from 1000 to 300,000 lbs. and permit measurements which are accurate to about 0.1%."—Hugh Odishaw, National Bureau of Standards.

1926. "This year we felt that jewels would improve the operation of our Indicators and adopted them." — I. A. Hunt, Federal Products Corp.

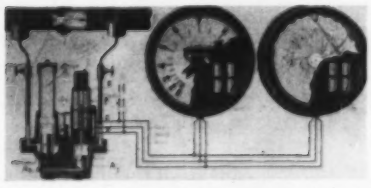
1926. "Permutit adapted the 'Ranarex' CO_2 recorder to measure specific gravity of all manufactured, natural, refinery and mixed gases as a guide to their proper processing, mixing, measurement and distribution." — K. F. Urquhart, for The Permutit Co.

1925-1927. "At this time the industrial transition from batch processes to continuous processing demanded control equipment suitable to the new conditions. This instigated the development of the proportional controller, and suitable valves with fitting characteristics (and eventually the addition of automatic reset to a proportional controller —the 'Stabilog Controller'—see 1929)." —Robert Barton, The Foxboro Co.

1926-1927. "Foxboro was the first to recognize and establish the principles of valve characteristics in connection with proportional control. (The conclusions of this study, including rules for valve sizing, were first published in Foxboro's Bulletin 167, copyrighted in 1930.)"—Robert Barton, The Foxboro Co.

1927. "First installation by L&N of frequency control system, for a New England power company, marked the beginning of coördinated control of a complete power system's frequency. Today, over 40,000,000 kw. of generating capacity are held at constant frequency by this type of L&N equipment."—H. M. Parshall, Leeds & Northrup Co.

1927. "First chrome-plated gage blocks of any kind were produced by Ford Motor Co."—O. E. Green, Johansson Div., Ford Motor Co.



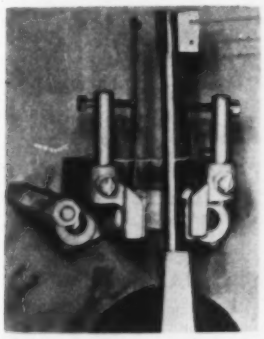
1927. "T. R. Harrison completed the design for a revolutionary type of electric flowmeter which won for him a certificate of merit award from the Franklin Institute. . . . The flow (and liquid level) meter he conceived used a novel inductance bridge principle which not only eliminated the stuffing boxes and pressure-tight connections previously necessary but, for the first time, brought about the continuous transmission of flow indications. This made possible flow control from a remote instrument. The new flowmeter introduced also the advantages of interchangeable range tubes: . . . possible to obtain a four-to-one change in meter capacity without disturbing the orifice plate and at the same time retain the same chart factor as in the original combination. In addition, inclusion in this instrument of an automatic planimeter which, for the first time, plainly recorded on the chart rim quantity of flow in units of weight or volume."—C. C. Roberts, Brown Instrument Co.

1927. "Leslie 'Class P' Pump Governor . . . the first self-contained internal-pilot piston-operated pump regulator featuring absence of rubber diaphragms or bellows and packed valve stems . . . In addition, automatic reset: use of outlet steam pressure balancing two equal and opposing diaphragms separated by a restricted orifice . . . high accuracy of regulation and good stability." — John S. Leslie, Pres., Leslie Co.

1927. "L&N developed the Wenner Potentiometer, based on a circuit idea conceived by Dr. Wenner of the Bureau of Standards. . . . exceptionally high precision for thermocouple temperature measurements in the laboratory. Accuracy was due mainly to minimization of thermal voltages." — H. M. Parshall, Leeds & Northrup Co.

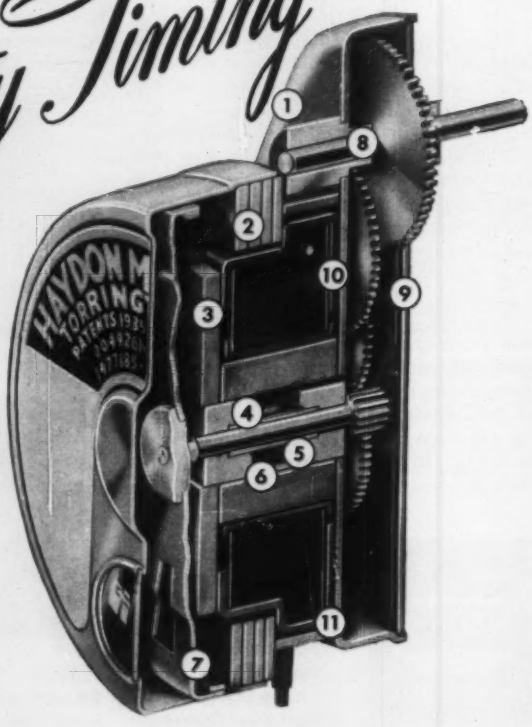
1927. "A new, improved design of tube fitting . . . provided a more positive leakproof connection . . . more diversified uses."—S. E. Voran, Parker Appliance Co.

1927. "Republic introduced Six-pen Multi-strip-chart Recording Instruments." — H. W. Stoetzel, Republic Flow Meters Co.



1927. "American introduced the first Dairy Recording Thermometer with an expanded area on the chart for pasteurizing service. The areas above and below the pasteurizing range were retarded (by the mechanism illustrated) in such a manner as to permit one recorder to be used for cooling, pasteurizing and sterilizing services with a single chart without damage to the instrument. . . . American Dairy Recording Thermometers were the first equipped with

FOR *Quality Timing*



HAYDON shows the way

This cross section of a Haydon timing motor illustrates a few of the exclusive, patented features that make Haydon synchronous motors and timers the most accurate and dependable in the field.

1 **Compact, sealed gear housing.**
2 **Shading coil construction gives high starting torque.**
3 **Field structure gives balanced torque characteristics.**
4 **Porous bronze graphite bearings filter lubricant to bearing surfaces.**
5 **Shaft housing seals lubricant away from motor shaft—prevents pumping.**
6 **Sealed reservoir for motor shaft lubrication.**
7 **Uniform reluctance ring rotor for uniform torque characteristics, rigidly held by spunover support.**
8 **Double bronze bearing on output shaft.**
9 **Lubricant carried by capillary attraction to each gear assembly individually, irrespective of mounting position of unit.**
10 **Protection against voltage surges with fold of insulation.**
11 **Projection-welded field assures accurate air gap and rugged construction.**

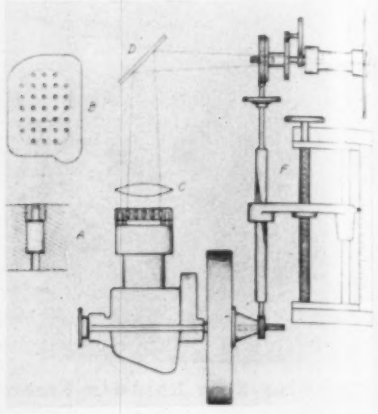
Comprehensive range of output speeds from 450 rpm to 1 revolution per 1000 hours makes Haydon motors universally adaptable. Write for our new 1948 Engineering Catalog covering all Haydon's motors and timers. For an actual timing motor demonstration at your desk, request a call by your Haydon representative.

WRITE HAYDON, 2001 ELM STREET, TORRINGTON, CONN.

HAYDON

MANUFACTURING COMPANY, INC.
TORRINGTON CONNECTICUT
HARNESS TIME TO YOUR PRODUCTS
SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

interchangeable bulb fittings per[mitting] use of one recorder on various t[ypes of] dairy equipment. . . ."—S. G[odwin] Manning, Maxwell & Moore.



1927. "A method of investigating combustion in an engine cylinder with a flat head was developed at the NBS. The cylinder head was provided with a number of transparent windows arranged in rows, and the head was viewed through an engine-driven stroboscope, as shown schematically in the diagram. Visual and photographic observations of flame travel were made with Pyrex glass windows. Windows of fluorite were used subsequently in place of glass for studies of infrared radiation."—Hugh Odishaw, National Bureau of Standards.

1927. "Federal was the first to bring out different types of graduations on the dials of Indicators. Our present 'Model C71' was the first new model having 100 graduations; the next, our 'Model C6K' having 80; next, 'Model C5M' having 60; and the 'C2I' with 100 graduations and reading in 0.0001". Notice the above Indicators carried graduations valued at 0.0005", 0.0001"."—I. A. Hunt, Federal Products Corp.

1927. "Fused-quartz-tube thermal expansion apparatus designed and constructed at the NBS for use in commercial laboratories. It is shown both uncovered and in use surrounded by an in-

a Tree grows in ROCHESTER!

THIS IS the Taylor tree of instrumentation. The acorn from which it sprang was our first Industrial Thermometer in 1895. Since then, the Taylor tree has grown with industrial processing. In fact, mass production in the process industries might never have been possible without the kind of versatile, accurate instrumentation and application know-how that we have been able to contribute. When you buy a Taylor Instrument, you buy the services of a group of scientists—which we believe is one of the largest and ablest in this or any similar industry. Whatever your processing problem—chemicals, petroleum, paper, textiles, food, milk, sugar, carbonated beverages, beer, distilled liquors, rubber, plastics—we can offer you a simple, dependable control system to assure top quality at minimum cost. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

Best way to get supplies fast

Air Express is the fastest possible way to get the supplies and equipment you need. That's because your shipments go on *every* flight of all the Scheduled Airlines. No waiting around. And Air Express packages are picked up and delivered right to your door at no extra cost.

This speedy service helps your business *keep moving* — lets you serve your customers better. Coast-to-coast delivery overnight is now routine. And with *low* rates, there's profit for you in Air Express. Use it regularly!

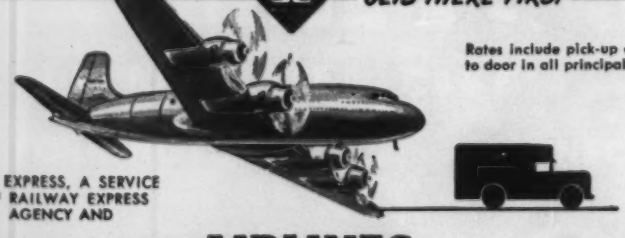
Specify Air Express-World's Fastest Shipping Method

- Low rates — special pick-up and delivery in principal U. S. towns and cities at no extra cost. • Moves on all flights of all Scheduled Airlines.
- Air-Rail between 22,000 off-airline offices.
- Direct air service to and from scores of foreign countries.

True case history: Electric switches located in Tulsa, Okla., were wanted in Newark, N. J., to complete equipment and fulfill contract date. **21½** lb. package picked up the 17th at 5:05 P.M., delivered 3:35 A.M., just 10 hours later. **1239** miles, Air Express charge only **$8.10.** Other weights, any distance, similarly inexpensive and *fast.* Just 'phone your local Air Express Division, Railway Express Agency for fast shipping action.

AIR EXPRESS
GETS THERE FIRST

Rates include pick-up and delivery door to door in all principal towns and cities.



AIR EXPRESS, A SERVICE OF RAILWAY EXPRESS AGENCY AND

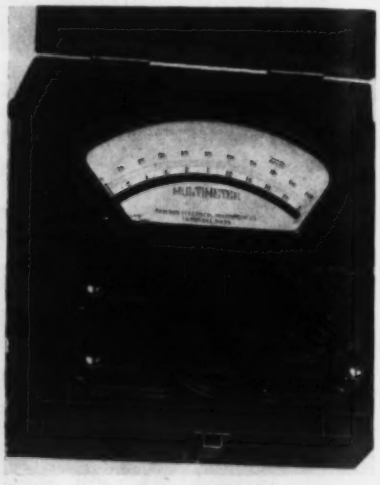
THE SCHEDULED AIRLINES OF THE UNITED STATES

sulating jacket with auxiliary a para- tus."—Hugh Odishaw, National B reau of Standards.

1927. "Development of success al in- strumentation for x-ray diffracti n. In December 1927 Dr. G. L. Clark (the father of industrial applications of re- search by the x-ray diffraction m thod) invited me to build some x-ray diff action apparatus for the newly-founded lab ratory at the University of Illinois. . . . I had to develop the present type of pinhole s stems as well as various types of cameras, such as flat cassettes for Laue type patterns, powder cameras for the various methods used in powder x-ray diffraction technique, goniom- eters for single crystal analysis (this goni- ometer being mounted in our universal cam- era where specimens could be rotated or oscillated), back reflection cameras, special powder cameras for penicillin work, and equipment for entirely new techniques, such as cameras for micro-radiography and our Weissenberg type camera . . . While Dr. Clark has never in any way had any con- nection with my plant he has been most gracious to coöperate in every way possi- ble."—J. Burton Hayes, Hayes Scientific Appliances.

This is not a history but a chronology

Read Foreword on page 33



1928. "The 'Multimeter' . . . need was felt for standardization of multi- ple-range instruments . . . a group of the most convenient ranges were put together in one instrument. To the best of our knowledge, this was the first attempt to provide a wide and continu- ous range of current and voltage measurements in one instrument. A copyright was obtained on the term "Multimeter" and this is still the ex- clusive property of the company."— A. J. Lush, President, Rawson Electri- cal Instrument Co.

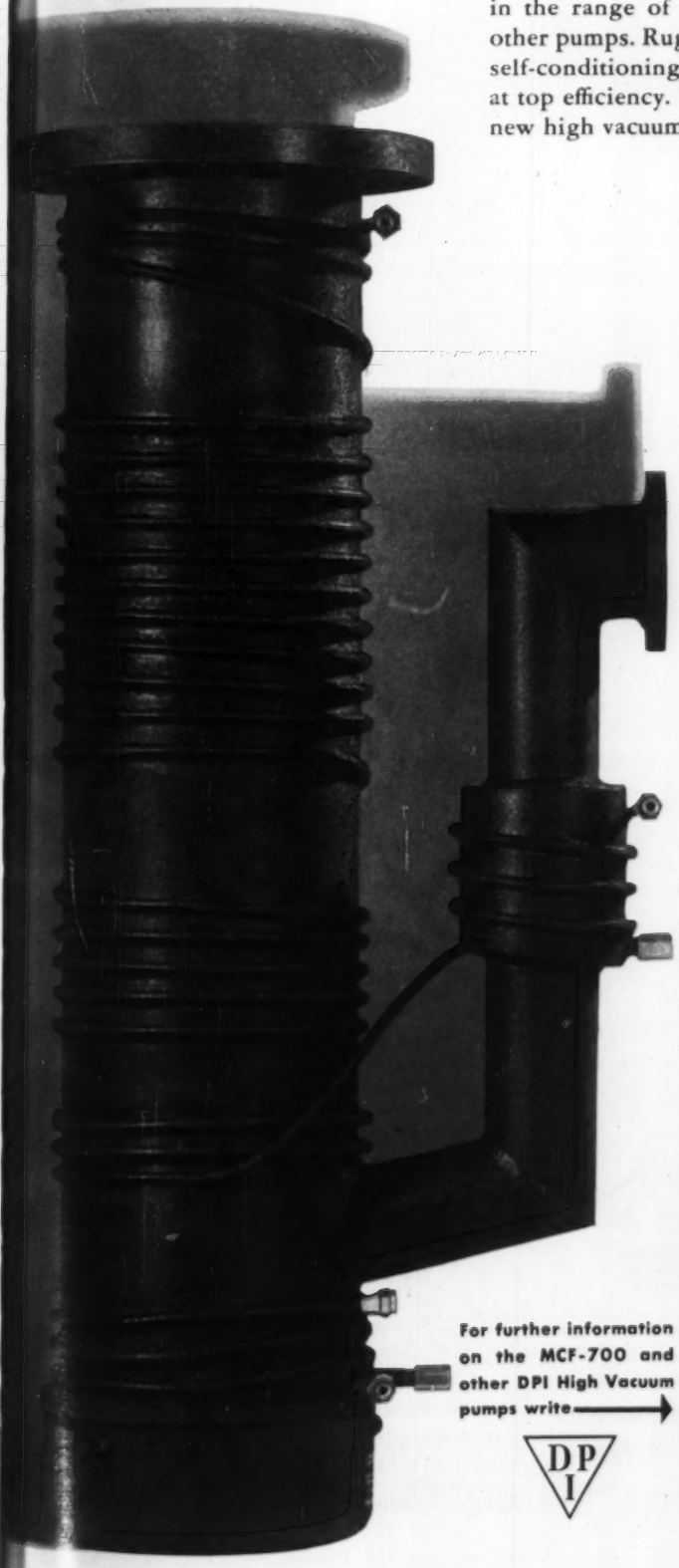
1928. "The Trendalizer, . . . one of the first successful attempts to provide automatic reset on electric control sys- tems. . . . In addition, the production of mechanical flowmeters, a furnace and hot oil interlock control system, and many improvements and new applica- tions of existing equipment." — C. C. Roberts, Brown Instrument Co.

1928. "The first electrical instrument for testing the moisture content of lumber . . . 'TAG-Heppenstall Moisture

For New High Speeds in the Lower Pressure Ranges—

THE MCF-700 HIGH VACUUM PUMP

WHEN you need high pumping speeds in pressures down to 10^{-6} mm of mercury, the performance of the new MCF-700 will meet your specifications exactly. This pump delivers from 100 to 500 liters per second in the range of 10^{-6} to 10^{-5} mm, — performance unduplicated by any other pumps. Ruggedly constructed, the MCF-700 operates on a unique, self-conditioning principle which keeps the fractionating jets operating at top efficiency. The tables below outline the essential features of this new high vacuum pump.



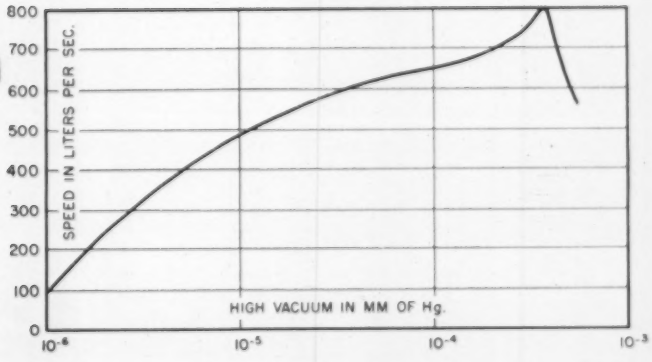
PHYSICAL DATA

High Vacuum Flange	6″ i.d., 9″ o.d. 8″ bolt circle
Forepump Flange	2⅜″ i.d., 3¾″ o.d. 3 5/16″ bolt circle
Height	29″
Length	14″
Width	9″
Construction:	
Casing	Seamless Steel
Jet Assembly	Aluminum and Steel
Cooling	Water
Weight	Approx. 40 lbs.

OPERATION DATA

Amount of Oil	500 grams
Recommended Oil	Octoil or Octoil-S
Forepressure	0.10 mm
Heater Power	800 watts
Heater Current	7.0 amp.
Heater Voltage	115 volts A.C. or D.C.
Speed	700 l/s
Ultimate Vacuum	5×10^{-7} at 25° C.

PERFORMANCE



For further information on the MCF-700 and other DPI High Vacuum pumps write →

DP I

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.

Rochester 13, N. Y.

Now Electrical Impulse Recording is *Instantaneous!*

Yes, Brush oscillographs draw *instant* pictures of electrical impulses. Eliminate delays and trouble when you want accurate, permanent, ink-on-paper recordings.

Recordings of strains, pressures and countless electrical phenomena can be made over a frequency range of D.C. to 100 c.p.s. Today Brush Oscillographs are available in Single, Double and Six Channel models. The magnetic Pen Motor is available separately for incorporation into equipment such as medical, geophysical and other highly specialized designs. Whenever desired, recordings may be stopped for notations on chart-paper.

Brush Model BL-913 D.C. Amplifier. Well adapted to the measurement of static or dynamic phenomena such as temperature, light, pressures, strains, etc.

Write today for detailed bulletin.

THE Brush DEVELOPMENT COMPANY

3605 Perkins Avenue • Cleveland 14, Ohio, U.S.A.

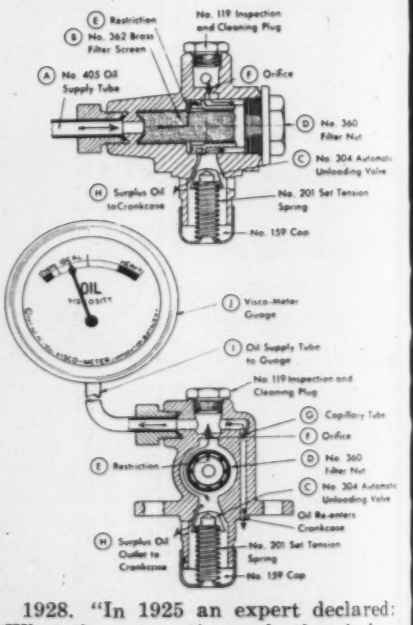
MAGNETIC RECORDING DIV. • ACOUSTIC PRODUCTS DIV.

INDUSTRIAL INSTRUMENTS DIV. • CRYSTAL DIVISION

Canadian Representatives: A. C. Wickman (Canada) Ltd. P. O. Box 9, Station N, Toronto 14

Meter' enabled operators to rea per-cent of moisture content . . . imme ately after the needle-pointed electrod had penetrated the wood."—George Te hune, C. J. Tagliabue Div.

1928. "The Fluxmeter . . . Previously, the only instrument for measurement of magnetic flux lines was the imported Grassot fluxmeter. The Rawson Fluxmeter . . . had several improvements . . . regular pivoted movement replacing the old galvanometer type suspension . . . the first really portable instrument of this type . . . usable anywhere without accurate leveling. A single electric push-button provided a rapid return to zero."—A. J. Lush, President, Rawson Electrical Instrument Co.


E Restriction
B No. 362 Brass Filter Screen
A No. 405 Oil Supply Tube
No. 119 Inspection and Cleaning Plug
F Orifice
D No. 360 Filter Nut
C No. 304 Automatic Unloading Valve
H Surplus Oil to Crankcase
No. 201 Set Tension Spring
No. 159 Cap
OIL
J Visco-Meter Gauge
I Oil Supply Tube to Gauge
No. 119 Inspection and Cleaning Plug
G Capillary Tube
F Orifice
E Restriction
D No. 360 Filter Nut
C No. 304 Automatic Unloading Valve
Oil Re-enters Crankcase
H Surplus Oil Outlet to Crankcase
No. 201 Set Tension Spring
No. 159 Cap

1928. "In 1925 an expert declared: 'What the automotive and other industries need is an instrument which will indicate if the lubricating oil *in* an engine is of the proper viscosity for the need of the engine during operation' . . . three years of development . . . the 'Visco-Meter' . . . when installed in the oil circulating system continuously measures viscosity and instantly indicates changes."—J. A. Baird, Visco Meter Corp.

1928. "TAG pioneered automatic control for saturation or rehydration of natural gas with a wet- and dry-bulb controller. . . . first put into operation on the New Orleans Public Service System. The TAG Saturation Recorder-Controller maintained constant relative

"Veeder-Readings"
ARE DIRECT READINGS

...THAT MINIMIZE CONVERSIONS, ERRORS, DELAYS

Put an end to the setting and reading of hairline-graduated dials on all types of machines.

Install a Veeder-Root Counting Device that will give direct and accurate *Control* over rate of feed, depth of cut, or any other phase of operation.

Then operators and inspectors get their Facts-in-Figures directly, plainly, *unmistakably*... in bold, easy-to-read figures that don't have to be converted, decoded or otherwise translated.

2217125

The Counting House of Industry

VEEDER-ROOT INC.

Hartford 2, Connecticut

In Canada: Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3. *In England:* Veeder-Root Ltd., Dickinson Works, 20 Purley Way, Croydon, Surrey.

Most Dependable Self-Operating Regulator Made
One of Our Many Types of Water Temperature Control
POWERS
THE POWERS REGULATOR CO.

NO. 11 TEMPERATURE REGULATOR

POWERS

ENGINEERING SERVICE FOR WATER TEMPERATURE CONTROL

When you have a problem requiring dependable regulation of water temperatures, consider the following advantages when you call Powers:

Over 55 Years of Experience gained in supplying temperature controls for almost every purpose in all types of buildings and industrial plants.

Most Complete Line of Controls Made—If you want control for closed or open tanks and vats . . . or if you want to thermostatically regulate the mixing of hot and cold water to deliver a mixture at a predetermined temperature . . . Powers can help you whether the flow of water is 1 gal. or 10,000 gals. per minute.

Service on Installed Equipment. With competent engineers in 47 cities, we are able to give prompt and efficient service whenever required . . .

CHICAGO 14, ILL. 2734 Greenview Avenue
NEW YORK 17, N. Y. 231 East 46th Street
LOS ANGELES 5, CAL. 1808 West Eighth Street

447

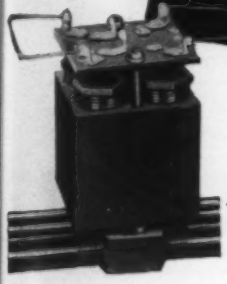
THE **POWERS** REGULATOR COMPANY

Phone or write for Catalog 3035 — Offices in 47 cities ● See your phone book

Low cost gas analysis!

ACCURATE...
SENSITIVE...
COMPACT...
RUGGED...

with **GOW-MAC** EVER-TITE **THERMAL CONDUCTIVITY UNITS**



FOR CHEMICAL ENGINEERS AND STUDENTS ONLY—

If hydrogen is your problem, consult these two important technical papers.

WEBB, G. A., and G. S. BLACK—Industrial and Engineering Chemistry, Analytical Edition 16, 719 (1944), "Determining Hydrogen in Gases with a Thermal Conductivity Apparatus."

D'OUVILLE, E. L., and K. E. HOWE—Petroleum Refiner, June 1947 "Thermal Conductivity Cells for Gas Analysis in Fischer-Tropsch Synthesis."

GOW-MAC Evertite Thermal Conductivity Cells will reduce your instrumentation cost for indicating, recording or control of hydrogen mixtures.

Inquiries from Laboratory Supply Houses Should be Addressed to Dept. SD.

GOW-MAC cells require no special instruments—give excellent results with standard accessories found in any laboratory or instrument department.

GOW-MAC INSTRUMENT CO.
22 LAWRENCE ST., NEWARK 5, NEW JERSEY

Into the Night...

Men of science are constantly probing . . . ever seeking . . . always wondering . . . never satisfied.

Every fresh discovery reveals anew the vastness of that "Great Undiscovered Ocean of Truth," and presents countless new problems in MEASUREMENT.

To keep abreast with the ever-changing needs of modern research, Hathaway engineers are constantly working on new measuring instruments, constantly improving older ones. Whatever may be YOUR new problem in MEASUREMENT OR CONTROL, Hathaway experience can help you.

Hathaway Type S8-B
12-Element Recording
Oscillograph

- For general-purpose laboratory and field use
- Advanced in design, exacting in craftsmanship
- Complete with every device for accuracy and convenience

ONE OF A COMPLETE LINE OF RECORDING OSCILLOGRAPHS, GALVANOMETERS, AND HIGH-SPEED RECORDERS

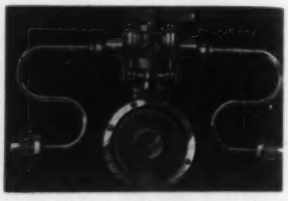
Write for Technical Bulletin SP-165 B

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

humidity . . . diaphragm valve operated by differential temperature between wet- and dry-bulbs, regardless of variations in the gas temperature."—George Terhune, C. J. Tagliabue Div.

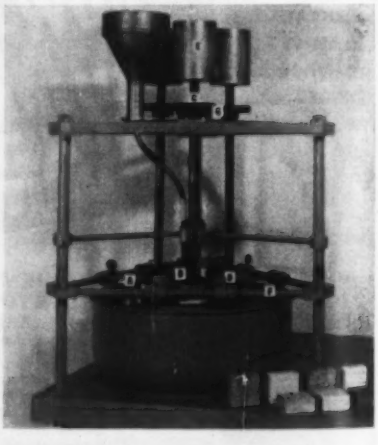
1928. "Sperry met the need for an instrument which would indicate the position of the ship's rudder with their Rudder Angle Indicator."—C. H. Jones, Sperry Gyroscope Co.

1928. ". . . seemingly simple yet important and far-reaching innovations that have universal acceptance, when T. R. Harrison released his patented universal mounting. . . . instrument could be mounted flush on a panel, or front-of-board, or on a wall, without changing its case."—C. C. Roberts, Brown Instrument Co.

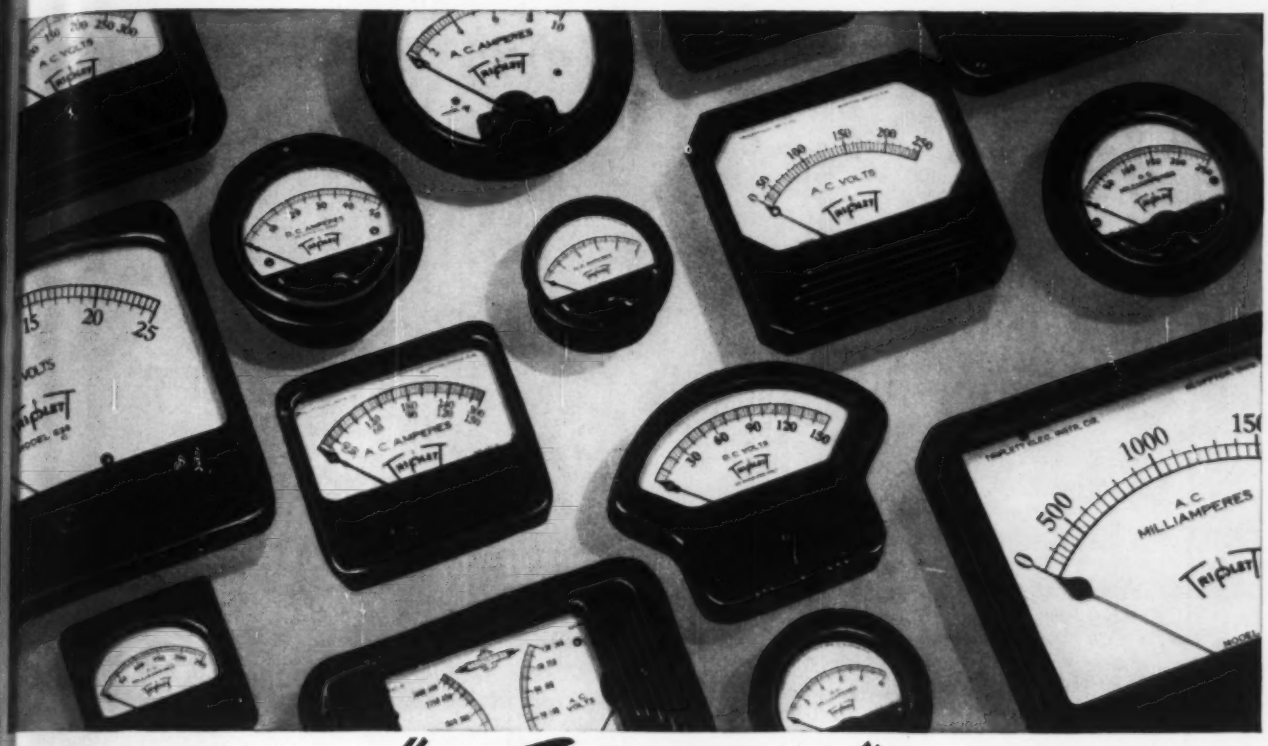


1928. "Fisher introduced the first successful liquefied petroleum gas regulator using composition valve disk and diaphragm, providing industry with the first regulator giving tight shut-off."—J. J. Mullen, Fisher Governor Co.

1928. "The first Electro-Analysis Apparatus which was truly portable and self-contained was manufactured by Eberbach. This unit is used for the quantitative analysis of metals by electro-deposition methods. The last twenty years have seen numerous developments in this apparatus."—L. W. Bittman, Eberbach & Son Co.



1928. Abrasion Tester. "This apparatus, developed at the NBS for testing stone and similar types of flooring materials, consists of a grinding lap *A* on which the specimens are revolved under a constant pressure during the test. No. 60 Alundum grit in the dry state is fed to the grinding lap at a constant rate during the test. One specimen is shown in the specimen holder *B* and a group of specimens is shown in the foreground. The hardness values are computed as a



A size, type, style "Triplett-made" for every need

"Half a Century of Instrument Know-How Is Built into These Fine Electrical Meters" . . . in sizes from 2″ to 7″ in a wide variety of case shapes and mounting arrangements.

No matter how specialized your requirements may seem, the chances are that Triplett has already engineered and tooled up for a design so nearly akin that a few inexpensive changes or additions will suffice.

Triplett . . . . A Self Contained Electrical Instrument Factory . . . From screw machine parts to plastic moldings, from moving elements to dial faces, all are fabricated in Triplett's modern air-conditioned factory. Equipped with special humidity and dust controls in assembly rooms. This self-contained factory means one overall profit markup with better quality control and consequent savings to you.

Complete meter satisfaction is yours in performance, appearance, and dependability. Let Triplett add lustre and give precision performance to your instrument panel.

"Complete Engineering Service" . . . Triplett maintains a field engineering staff available on short notice. These engineers are ready to help you with your problems and to bring you the latest practices in instrumentation from the Triplett laboratories. Complete facilities for shock, vibration and humidity testing as required under JAN specs.

Sizes 2″ to 7″
Round or Square

A.C., D.C.,
R.F., Rectifier or Dynamometer

Triplett can supply on short notice electrical meters in 2″, 3″, 4″, 5″ 6″ and 7″ sizes in round, rectangular, square and fan shapes; wide flange, narrow flange, flush, projection and portable. Molded and metal cases. Rear illumination, special dials and other features available on most models.

Be sure your files are up-to-date with current Triplett catalog and descriptive literature. Address, Dept. G18 and specify any particular types in which interested.

TRIPLETT ELECTRICAL INSTRUMENT CO. • BLUFFTON, OHIO
Representatives in Principal U. S. and Canadian Cities

TRIPLETT

For BETTER *and* SAFER GROUNDING

"MEGGER"* GROUND TESTER

For measuring resistance to earth of man-made ground connections, used with generating stations, substations, transmission towers, lightning arresters and machine frames. Grounding for protection . . . for insurance.

Check **THESE FEATURES** to see *why* the "Megger" Ground Tester is used for ground resistance measurements . . . and *how* it can do a job for you.

- Has its own hand generator; requires no batteries or other external power supply.
- Direct-reading in ohms —"Like a voltmeter."
- No calculations required.
- Only one set of connections.
- No adjustments or "balancing."
- Self-contained, rugged and portable.
- Unaffected by the exact resistance of the reference grounds.
- Unaffected by stray current in the earth either a-c or d-c, or by polarization or electrolysis.
- Covers a wide range of resistance—0-3 up to 0-30,000 ohms.
- Represents only a fraction of the cost of adequate grounding protection.

For a full description of the "Megger" Ground Testers, including the principle of operation, applications and how to use them, send *today* for Catalog 25-I.

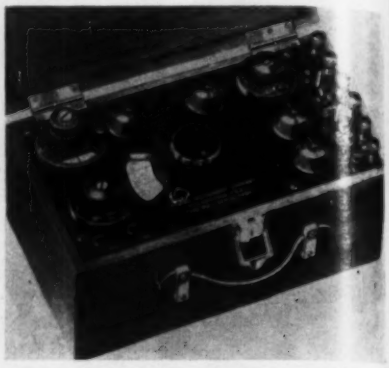
*REG. U. S. PAT. OFF.

JAMES G. BIDDLE CO.

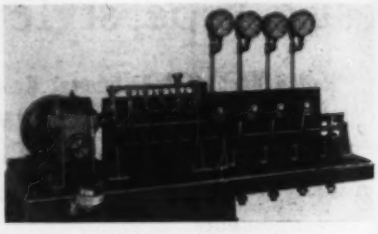
ELECTRICAL & SCIENTIFIC INSTRUMENTS

1316 ARCH STREET • PHILADELPHIA 7, PENNA.

reciprocal of the volume loss for given number of revolutions." — Hugh Odishaw, National Bureau of Standards.



1929. "The Thwing-Albert Treasure Chest, a potentiometer type instrument, was developed to . . . calibrate and check all types and makes of pyrometers and thermocouples with a great degree of accuracy and, if necessary, while the equipment is in service. It combined several pieces of apparatus into one instrument, thus eliminated the need for temporary wiring, . . . exclusive self-checking feature . . . range of 101 millivolts." — F. W. Eitzel, Thwing-Albert Instrument Co.



1929. "Process Time-cycle Controllers. . . . problems of measurement involving time were continually being presented for solution to Bristol Engineers. . . . Bristol organization . . . played an important part in pioneering the development of the process time-cycle controller. This instrument automatically performs and accurately times an entire series of operating functions, . . . has been manufactured in many forms, including models for simple operations and for highly intricate processes. (Photo shows one built before 1929.)"— G. P. Lonergan, The Bristol Co.

1929. "Bailey Thermo Hydraulic Feed Water Regulator introduced. . . . self-operated controller unique in that it employed an all-metal hydraulic system and a tight seating balance valve."— E. B. Bossart, Bailey Meter Co.

1929. Proportional-Reset Control Action. "The 'Stabilog' Controller was produced, the first control instrument embodying the principle of proportional reset control action. The importance of this development cannot be overemphasized, as it made possible the introduction of fully automatic control into continuous-process industries, thereby advancing the technological development and the productivity of such industries,

2-inch wattmeter....

(Electrodynamometer Type)

Another Simpson First....

...for discriminating users of fine panel instruments

(ACTUAL SIZE)

Also available in various sizes and case styles. For complete information write for bulletin.

Simpson ELECTRIC COMPANY 5200-5218 West Kinzie Street Chicago 44, Illinois

INSTRUMENTS THAT STAY ACCURATE

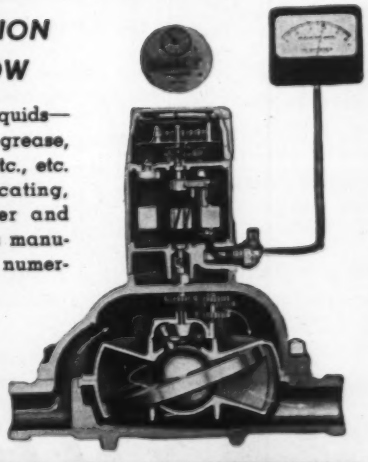
In Canada Bach-Simpson Ltd. London, Ont.

NEW

HAYS VERIFLOW TOTALIZING-INDICATING METER

Featuring

REMOTE INDICATION OF RATE OF FLOW



For practically all liquids—tar, molasses, crude oil, grease, paint, varnish, syrups, etc., etc.—for measuring, indicating, totalizing flow of water and chemicals in continuous manufacturing processes and numerous other uses. Its remote indicating feature is new—get the complete story.

SEND FOR BULLETIN 46-766

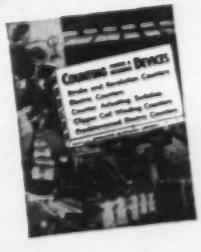
The HAYS CORPORATION

COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A.

SMALL COUNTERS

of GREAT DEPENDABILITY

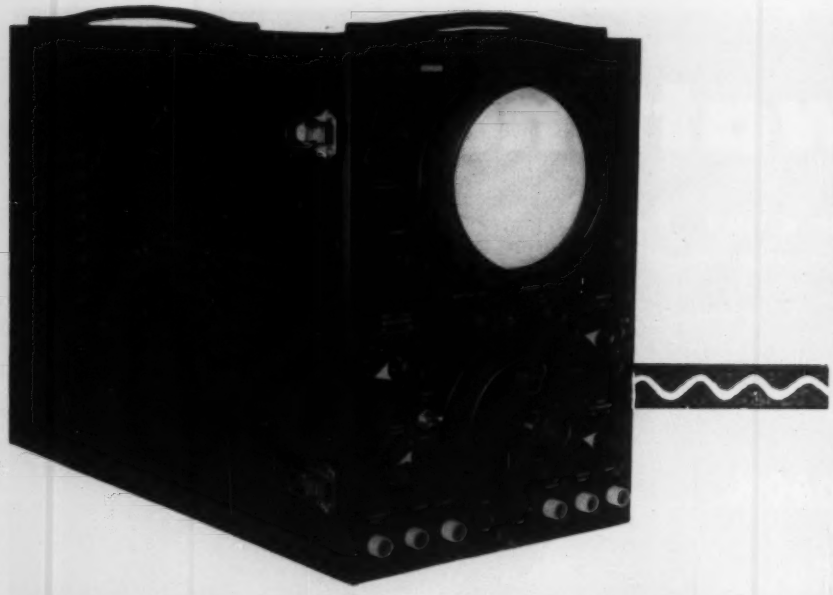


Small space requirement, low-cost and tamperproof construction make SMC counters ideal for built-in applications. Many types of Operating Arms including built-in overtravel protection — Top Coming or Top Going arm action — Right or Left shaft extension of any desired length. Speeds to 600 CPM. Non-reset. Send application details for sample.

Production Instrument Company

702 W. JACKSON BLVD., CHICAGO 6, ILL.

Manufacturers of Counting, Timing and Recording Devices



CRYSTAL-CONTROLLED TIMING MARKERS ACCURATE TO PLUS/MINUS 0.02%.

WIDE VARIETY OF SWEEP SPEEDS: 4, 10, 25, 100, 1000 or 4500 MICROSECONDS MAY BE SELECTED.

PRECISION, CALIBRATED SWEEP-DELAY CIRCUITS.

EXTENDED WIDE-BAND AMPLIFIERS: SINE WAVE RESPONSE DOWN 3 db AT 8 mc, DOWN 6 db AT 11 mc.

All this . . . and more too, in the New DU MONT Type 256-D CATHODE-RAY OSCILLOGRAPH

Type 5CP-A cathode-ray tube, 4000 v. accelerating potential.

Sweeps (R): 25, 10, 4 microseconds; delayable to cover any portion of the 100 microsecond A Sweep from 4 microseconds up. 25 and 10 microseconds: delayable to cover any portion of the 1000 microsecond A Sweep from 5 microseconds up.

Delay accuracy plus/minus 0.1% of full scale. First few microseconds may be observed on the 4 or 10 microseconds A Sweeps. Approx. 0.3 microsecond required to start sweep.

Triggered internal and triggered external operation.

Intensity modulation: Input available at Z IN position of markers switch.

Vertical Deflection—Direct: Deflection factor: 79 peak-to-peak v/in.; 0.7 peak-to-peak v/in. through amplifier. Polarity: positive signal deflects upward. Maximum input voltage: 600 v d-c plus peak a-c. Video Amplifier: Attenuator: 1:1, 3:1, 10:1, 30:1 and 100:1, stepped, R-C compensated.

Primary power: 115 v, 60 cps [usable to 1200 cps], 220 watts; size: 11⅜" w., 16¼" h., 26" d.; wt.: 104 lbs.

★ Ideally suited for applications where a variety of sweep lengths, accurate sweep-delay circuits, crystal-controlled timing markers, wide-band video amplifier and variable internal trigger generator are mandatory.

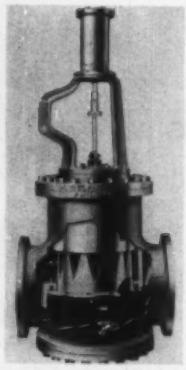
Such applications embrace television transmitter and receiver research; study of multi-channel, pulse-time modulation systems; nuclear research; and general applications wherein high-speed, short-duration phenomena of low repetition rate are examined.

Immediate delivery! To any destination in continental U.S.A. (Type 256-D; Cat. No. 1296-E) delivered price $1705.00.

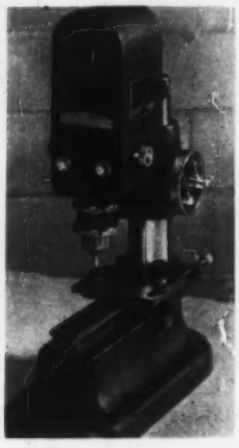
DUMONT

ALLEN B. DU MONT LABORATORIES, Inc.
Passaic · New Jersey
Cable Address: Albeedu, Passaic, N. J., U. S. A.

previously handicapped by the lack of suitable automatic control equipment. The first 'Stabilog' Controller was identified as the 'Model 10.' The 'Model 20,' introduced almost simultaneously, differed only in details of construction."—Robert Barton, The Foxboro Co.



1929. "Cylinder-operated control valve of the balanced V-port type . . . In deviation from previous practices, the valve disk with the controlling V-port was stationary and was attached to the web of the valve. . . . only opening at the bottom to admit the incoming flow. . . . any unbalance due to static pressure was avoided as far as the movable control part (the cylinder) was concerned . . . used for high pressure drops . . . V-port disk can be removed through the bottom flange without removing valve from line."—E. Wolff, Chief Engineer, H. Belfield Co.



1929. "The Sheffield 'Electrichek' . . . the first commercial comparator using colored electric signal lights. . . . used for determining whether a dimension is within tolerance, oversize, or undersize. . . . an extremely rapid inspection instrument for production work, . . . accurate in checking both high and low limits to within ten millionths of an inch. Instrument shown is included in the Sheffield permanent exhibit at the Smithsonian Institution."—C. W. Hamilton, Sheffield Corp.

1929. "'Red-reading-Mercury' was born. (Trade-mark and wording patented) . . . a revolutionary new idea, whereby the silver-mercury column shows a brilliant red by means of reflection . . ."—A. E. Honningford, Palmer Thermometers Inc.

1929. "First installation of Bailey Three-element Feed Water Control placed in operation. This regulated the feed water flow to correspond to steam flow and readjusted it by boiler-drum

INSTRUMENTATION IS KING
and LESLIE features simplicity

LESLIE Controllers and Regulators are precision-built, ruggedly constructed and feature, as *standard* trim, hard faced seat rings, 500 Brinell hardened main valves, corrosion resistant internal parts—all unbeatable combinations engineered to lower your power costs.

Pressure Reducing Valves—with narrow throttling range for fast response and high accuracy of regulation. Single-seated for positive dead-end control—low maintenance cost—all internal working parts renewable—complete overhaul without removal from pipe line.

Pressure Controllers—with choice of several operating mediums—air, gas, water or oil-operated, designed for non-continuous leakage operation, particularly important for intermittent control of steam flow and emergency make-up or cut-off requirements.

Diaphragm Regulating Valves — with single seated, fully balanced, no pressure drop limitation design. Smooth, throttling control and tight shut-off. Furnished up to 8″ inclusive, semi-steel and bronze bodies. Cast steel, ½″—4″.

Pump Governors—with automatic reset by balancing the delivered steam pressure with two equal and opposing metal diaphragms separated by a restricted orifice for reciprocating and turbine-driven pumps. Single seated, hand-wheel adjustment with wide adjustable pressure range.

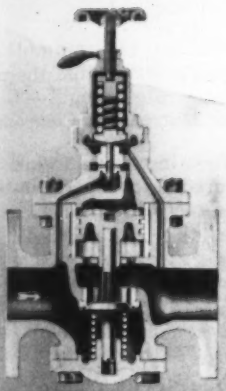
Temperature Regulators — with anticipating action accomplished by controlling both pressure and temperature regulation with a single pilot valve. Rugged thermostatic element, diaphragm construction has 100°F. adjustable thermostatic temperature range.

SEND FOR your copy of applicable bulletin.

LESLIE CO. 299 Grant Avenue Lyndhurst, New Jersey

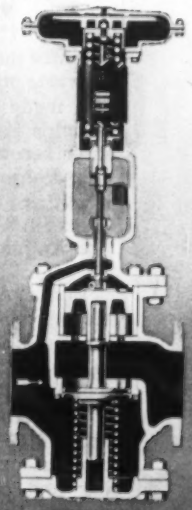
Look for LESLIE REGULATORS under "Valves" or "Regulators" in your classified telephone directory in the following cities where LESLIE factory trained engineers are located:

Akron, Ohio	Dallas, Texas	New Orleans, La.	San Francisco, Cal.
Albany, N. Y.	Detroit, Mich.	New York, N. Y.	Savannah, Ga.
Atlanta, Ga.	Greenville, S. C.	Orlando, Fla.	Seattle, Wash.
Baltimore, Md.	Houston, Texas	Philadelphia, Pa.	Spokane, Wash.
Birmingham, Ala.	Kansas City, Mo.	Pittsburgh, Pa.	St. Louis, Mo.
Boston, Mass.	Kingsport, Tenn.	Portland, Ore.	Syracuse, N. Y.
Bridgeport, Conn.	Los Angeles, Cal.	Providence, R. I.	Toronto, Ont., Can.
Buffalo, N. Y.	Louisville, Ky.	Richmond, Va.	Tulsa, Okla.
Chicago, Ill.	Memphis, Tenn.	Rochester, N. Y.	Vancouver, B. C., Can.
Cincinnati, Ohio	Minneapolis, Minn.	Rutherford, N. J.	Wilkes-Barre, Pa.
Cleveland, Ohio	Montreal, Que., Can.	San Antonio, Tex.	Youngstown, Ohio
		Honolulu, Hawaii	

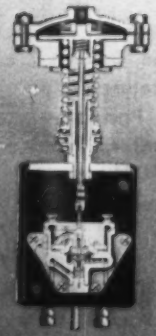


Pressure Reducing Valves for Steam, Air or Gas. Inlet pressures 25 psi to 1500 psi steam, to 3000 psi air or gas
Bulletin 461

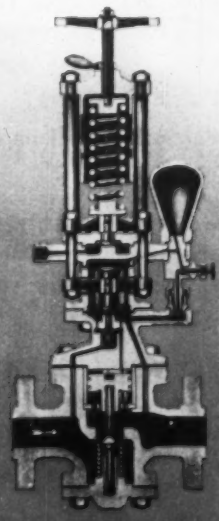
Self-Cleaning Strainers for steam, air, gas or liquid service.
Bulletin 468



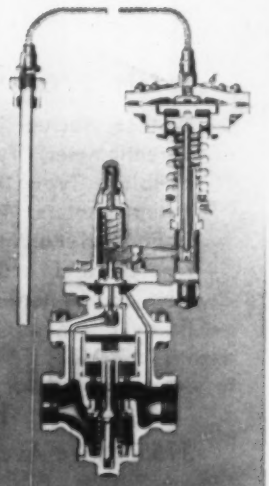
Diaphragm Regulating Valves for controlling steam, hot or cold liquids and gases using Instrument Control. Inlet pressures 0-1500 steam, 0-2500 cold liquid or gas.
Bulletin 462



Control Pilots for regulating flow of air, clean water or light oil to operate Diaphragm Regulating Valves.
Bulletin 462



Constant and Excess Pressure Pump Governors. For pump discharge pressures 25 psi to 1000 psi.
Bulletin 463



Temperature Regulators for control of steam, condensate, gas, or fluid, for process heating or cooling.
Bulletin 464

ESTABLISHED 1900
LESLIE CO.

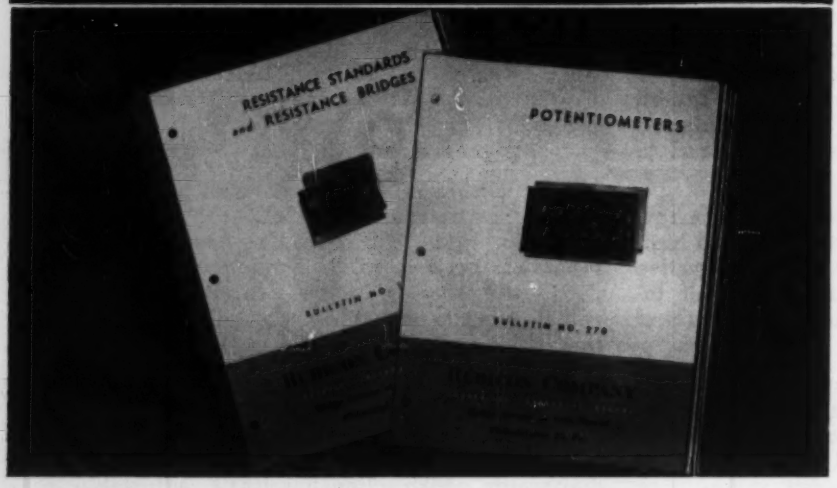
Lowest Overall Cost per Operating Year.

PRESSURE REDUCING VALVES • PUMP GOVERNORS • PRESSURE CONTROLLERS
TEMPERATURE REGULATORS • SELF CLEANING STRAINERS • LESLIE-TYFON WHISTLES

For those who employ

ELECTRICAL MEASUREMENTS

In Laboratory, Plant or Field



...to supplement your Rubicon files...

NEW INSTRUMENTS • NEW TECHNICAL DATA

BULLETIN 100—"Resistance Standards and Resistance Bridges"

Included are complete descriptions of Rubicon Standard Resistors (Bureau of Standards and Reichsanstalt Types), Standard Shunts, Decade Resistance Boxes, Unmounted Decade Resistors, Wheatstone Bridges (laboratory and portable), Mueller Resistance Thermometer Bridge, Kelvin Bridges (laboratory and portable), and Limit Bridges (for production testing).

BULLETIN 270 — "Potentiometers"

Concise, factual information on Rubicon Type B High Precision Potentiometer, Type C Microvolt Potentiometers (single and double), Type D Microvolt Potentiometers, Portable Precision Potentiometers, Type S Students' Potentiometer, Temperature-Calibrated Potentiometers, Brooks Model 7 Deflection Potentiometer, and accessories including volt boxes, standard cells, keys and batteries.

RUBICON COMPANY

Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For your convenience, fill out and send this coupon today!

RUBICON COMPANY
3755 Ridge Avenue • Philadelphia 32, Pa.

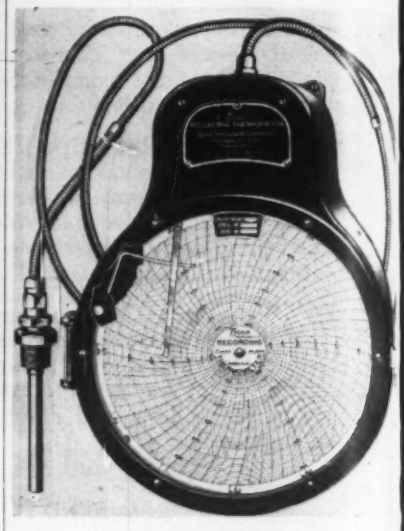
Please send Bulletin 100 ☐ Bulletin 270 ☐

Name.....

Organization.....

Address.....

water level. Thus it made all wances for changes in drum water leve before they happened. This control ha gained wide acceptance for use on lar e high-pressure boilers. Its speed of r sponse meets that of modern fuel- urning equipment and permits the se of smaller boiler drums, thereby r ducing the cost of high pressure units."—E. E Bossart, Bailey Meter Co.



1929. Recording thermometers "... the case was inverted and the suspended pen came into being."—C. S Conner, Taylor Instrument Companies

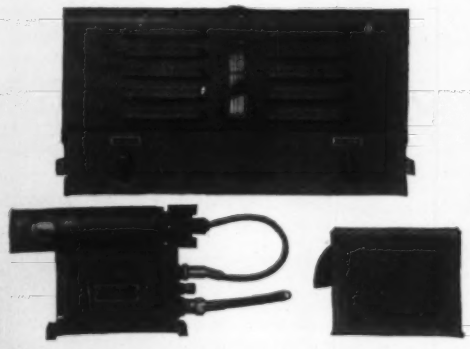
1929. "The first instrument which inherently measured volt-amperes instead of watts was a self-contained unit and was made available in the 'Model LR Graphic Meter' . . . original design has since become outmoded by a much simpler design of kva.-measuring elements which are now available in the present 'Model AW.' . . ."—Don Brewer, Esterline-Angus Co.

1929. "A newly-designed potentiometer developed and patented by T. R Harrison became available to pyrometer users. . . . a rebalancing mechanism which 'felt' the galvanometer pointer always from the same side. This mechanism . . . inaugurated a line of sensitive, accurate, and dependable recording and control instruments that remained basically unchanged for more than ten years. In addition, the accuracy of recording instruments was further advanced by the introduction of humidity compensation for the recording chart. This overcame errors from expansion and contraction of the chart paper."—C. C. Roberts, Brown Instrument Co.

1929. "Lieutenant 'Jimmy' Doolittle accomplished the first blind take-off and landing in the history of aviation. His plane (with fully-enclosed cockpit) was equipped with the Sperry Artificial Horizon and the Directional Gyro."—C. H. Jones, Sperry Gyroscope Co.

1929. "Ashcroft Gages and American Dial Thermometers were first to be

For INFRA-RED SPECTROSCOPY
The Golay DETECTOR



A Superior Detector-Amplifier System for Use in Infra-Red Spectroscopy. Has RMS ENI of better than 1×10^{-10} Watts. Write for Eplab Bulletin No. 10.

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
NEWPORT RHODE ISLAND U. S. A.

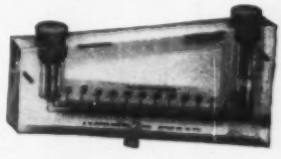
Specified
by Manufacturers and Architects
DWYER TRANSPARENT
AIR FILTER GAGES

Recommended by leading air filter manufacturers, DWYER Gages warn against over-accumulation of dust and dirt which increase filter resistance ... show proper time for cleaning or replacing air filters ... thus prevent air delivery from dropping below permissible minimum flow.

Because there are no complicated three-way valves for venting to Zero, DWYER Gages are permanently accurate. Over-Pressure Safety Traps, a DWYER exclusive, prevent loss of fluid at all times. Solid transparent plastic body insures highest visibility.

For complete information, ask for DWYER Bulletin No. 187

No. 272-AF "Flex-Tube" Air Filter Gage
Range 0-1" Scale Length 3½"
Price (complete with accessories) $10.50



No. 250-AF Air Filter Gage
Range .10-0-1.0" Scale Length 5½"
Price (complete with accessories) $23.50

F. W. Dwyer Mfg. Co.
305 South Western Avenue, Chicago 12, Illinois

THERMOCOUPLE WIRE

C. P. PLATINUM AND C. P. PLATINUM-RHODIUM

PRICES VARY WITH MARKET

QUOTATIONS ON REQUEST

Manufactured, Calibrated and Guaranteed By

THE AMERICAN PLATINUM WORKS
231 NEW JERSEY R. R. AVE., NEWARK 5, N. J.

AC-ME RECORDING —GRAVITOMETER—

This instrument accurately records the changing gravity of gas and automatically corrects for variation in barometric pressure and temperature.

●

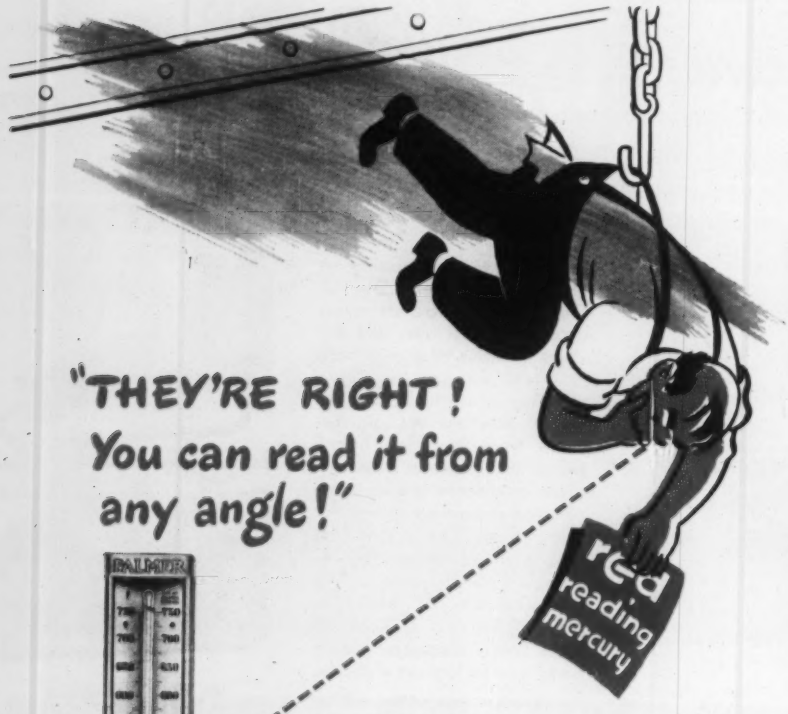
The instrument does not contain rotating parts thereby eliminating a major source of wear.

●

Sturdy construction and simplicity of operation contribute to accurate operation with a minimum of maintenance.

Complete line of Scientific Laboratory Equipment
— Write for Catalog No. 30-A —

THE REFINERY SUPPLY CO.
623 E. 4th ST., TULSA 3, OKLAHOMA



This fellow has gone to a lot of trouble to prove how easily you can read this new Palmer Thermometer. The new Palmer Extruded Brass Case plus famous "Red-Reading-Mercury" does the trick! You now get a full, easy-to-see scale with large, clear numerals.

Other new features include "snap-on" cap; double-strength, non-rattling glass; dustproof, fumeproof case. In 7, 9 and 12 inch case sizes with chrome finish; in 4 and 6 inch sizes with durable nickel finish. Write for new illustrated brochure, "The Story of Palmer Thermometers."

AND REMEMBER— specify this new thermometer on original equipment purchased from your jobber or equipment manufacturer — there should be no extra charge!

PALMER THERMOMETERS INC.

Mfrs. of Industrial, Laboratory Recording and Dial Thermometers

2511 NORWOOD AVENUE
CINCINNATI 12, OHIO

Canadian Plant
King and George Sts., Toronto 2

WHATEVER YOU CALL AN INSULATION TESTER

THE NEW

MODEL B-7 MEGOHMER

IS TOPS

COMBINED PRECISION OHMMETER & MEGOHMMETER
0-20, 0-200 MEGOHMS. 0-200, 0-20,000 OHMS.

Reads as low as 1/10 of 1 Ohm to as high as 200 Megohms. 2 Test Potentials 250/500 Volts. No cranking, no wavering of pointer. Saves time and effort. Simplifies Insulation Testing. Ideal for low resistance testing too.

WRITE FOR NEW BULLETIN 440

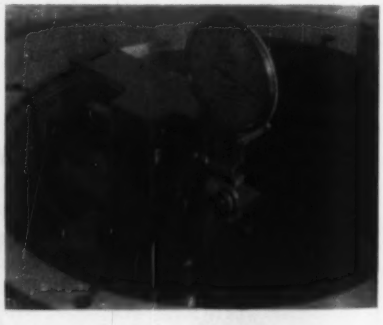
HERMAN H. Sticht COMPANY, INC.
27 PARK PLACE NEW YORK 7, N. Y.

housed in Phenol plastic case with threaded Phenol rings . . . lighter weight and corrosion resistance superior to [metal] cases which were not suitable for all services."—S. Goodwin, Manning, Maxwell & Moore.

1929. "Bodine introduced a line of worm-gear speed reducers. The smaller sizes immediately found their way into recording and controlling instruments . . . quite universally adopted by the leading instrument manufacturers."—W. M. Yogerst, Bodine Electric Co.

1929. "A glass of high transparency and minimum color was developed for the tubing used to make colorimeter tubes, such as Nessler tubes."—J. J. Moran, Kimble Glass.

1929. Quartz Crystal Frequency Standard. "Frequency standards were greatly improved by use of quartz crystal resonators and oscillators. In 1929 each of the four standards shown in this photo was controlled by a doughnut-type 100-kc. quartz crystal unit. By careful mounting and control of operating conditions, an accuracy of one part in ten million was obtained."—Hugh Odishaw, National Bureau of Standards.



1929. "Thread Pitch Indicator developed by the NBS for precision measurement of pitch of plug and ring thread gages and of lead screws by means of precision gage blocks. This provides a convenient and precise means of measurement of both external and internal screw threads."—Hugh Odishaw, National Bureau of Standards.

1930. "Foxboro brought out the Dual Dry Bulb Temperature Controller for reversing type dry kilns."—Robert Barton, The Foxboro Co.

1930. "High-precision a-c. resistors of extremely low residual inductance and capacitance were developed by L. & N. Novel feature of this development was the use of a woven structure for

LOW PRESSURE DIAPHRAGM GAUGE

MARSHALLTOWN Figure 83 is a very sensitive instrument utilizing a diaphragm for pressure communication, and is recommended for extremely low pressure service.

The following standard dials reading in inches of water are available—0-15", 0-30", 0-60", 0-100", 0-150".

Ounce graduated dials can also be supplied in a range from 16 ounces to five pounds.

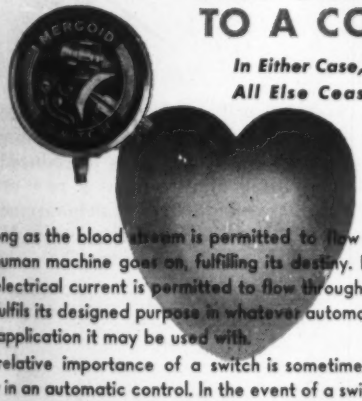
It is available in the 2½", 3½", and 4½" dial sizes and mounted in a black enameled, deep steel case. Write for details and price.

MARSHALLTOWN manufactures one of the most complete lines of indicating pressure gauges—there is a Marshalltown gauge for every purpose and pressure.

Marshalltown Mfg. Co., Marshalltown, Iowa

WHAT THE HEART IS TO LIFE THE SWITCH IS TO A CONTROL

In Either Case, When One Fails All Else Ceases To Function

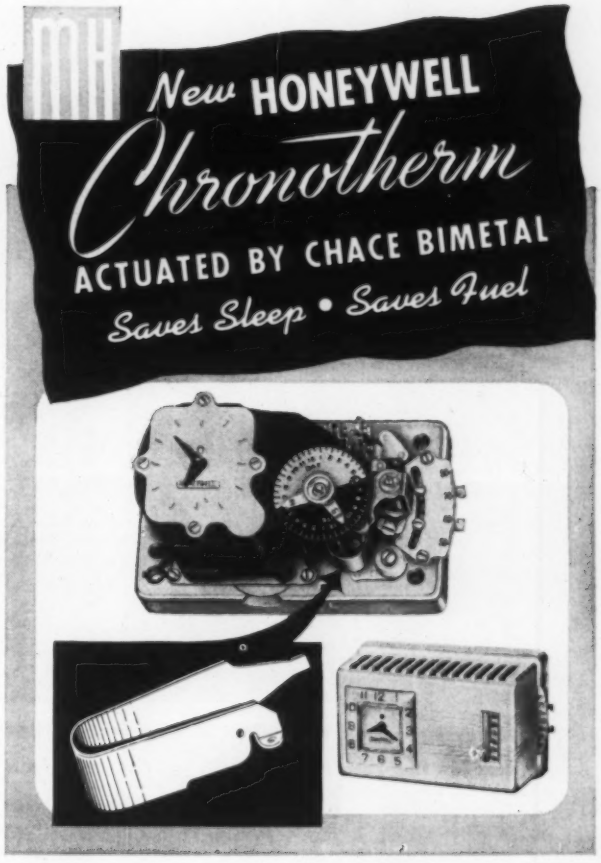


As long as the blood stream is permitted to flow through the heart, the human machine goes on, fulfilling its destiny. Likewise, as long as the electrical current is permitted to flow through the switch the control fulfils its designed purpose in whatever automatic heating or industrial application it may be used with.

The relative importance of a switch is sometimes overlooked, especially in an automatic control. In the event of a switch failure, as in the case of a boiler pressure or temperature limit control, as well as other important applications, the failure may prove hazardous and costly. That is why from the very beginning, Mercoid Automatic Controls were equipped exclusively with the now famous hermetically sealed Mercoid mercury switches, known and used the world over. They provide an electrical contact designed for millions of perfect operations —one reason why Mercoid Controls are noted for their long life and better performance. Mercoid switches are immune to dust, dirt, moisture or corrosion. They are not subject to open arcing, pitting or sticking of the contacting surfaces. That is the reason why Mercoid Controls are following the Army in some of the far outposts where adverse and extreme humid weather conditions exist.

There are many other important features incorporated in Mercoid Controls, but in the meantime, remember the all-important Mercoid Switch—the unfailing heart of Mercoid Controls.

THE MERCOID CORPORATION, 4221 BELMONT AVENUE, CHICAGO 41, ILLINOIS



No. 11—Minneapolis-Honeywell Regulator Co.

The new Chronotherm, manufactured by Minneapolis-Honeywell Regulator Co., is an instance of the use of Chace Thermostatic Bimetal in the field of heating, ventilating and air conditioning. The Chronotherm provides control of room temperature at day and night levels as selected, and is a neat timepiece as well. Day or night settings may be changed by a touch on the external adjustment lever for periods of six hours or more. The cam-type setback mechanism provides gradual morning pickup to prevent "over-shooting," relieves the weary householder of the annoyance of either turning up the heat at an early hour or starting his day in a chilled house, then hands him a bonus of a 10% better saving in fuel consumption.

The Thermostatic Bimetal which actuates this efficient temperature responsive device is sensitive but rugged, a typical product of W. M. Chace Company.

W.M. CHACE CO.
Manufacturers of
Thermostatic Bimetals
1609 BEARD AVE. • DETROIT 9, MICH.

PERMOPIVOTS of PERMOMETAL*

*T.M. REG.

for PRECISION INSTRUMENTS

- LONG LIFE thru wear and vibration Resistance
- NON-ABRASIVE
- NON-MAGNETIC
- NON-CORROSIVE

For an illustrated description of how PERMOPIVOTS are made, ask for the new PERMOPIVOT booklet . . . Free on request.

PERMO INCORPORATED CHICAGO 26

MANUFACTURING METALLURGISTS

The Smartest 3¢ You Ever Invested !

Three pennies in postage will bring you *the* answer to *real* cost reductions in marking wires, leads, circuits, relays, parts, etc.

• As alert production, maintenance, and repair men everywhere have discovered, *QUIK-LABELS* do the job better, faster and cheaper than string tags, roll tapes, decals, stencils, metal tabs, etc.

You can't afford not to look at *QUIK-LABELS* . . . particularly when a 3c stamp will bring you FREE SAMPLES by return mail. Clip that convenient coupon now. W. H. BRADY COMPANY — *Identification Specialists* — Milwaukee, Wisconsin.

W. H. BRADY COMPANY
804 North 3rd Street
Milwaukee 3, Wis.

Please send me FREE samples of QUIK-LABELS, the modern time and money saving way to mark wires, leads, circuits, relays, parts, etc.

Name_____

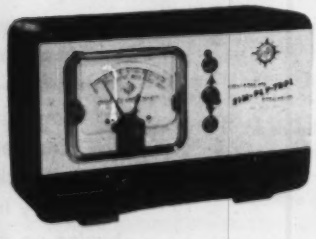
Position_____

Please attach to your BUSINESS letterhead

CONTROLLING

SIM-PLY-TROL PYROMETER

PAT. APPLIED FOR



INDICATING PYROMETER
plus
AUTOMATIC CONTROL
plus
LIMIT CONTROL
plus
AUTOMATIC SAFETY CUT OUT

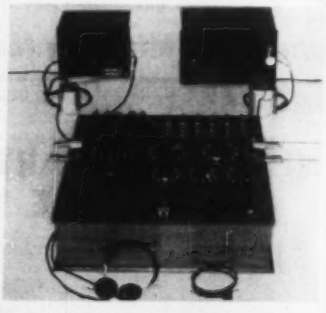
Only **$59.50** MODEL 1631 0-2500° F. F.O.B. CHAGRIN FALLS

OTHER RANGES FROM -350°F. TO 2500°F.
SIMPLE INSTALLATION
CONTACT METERS (DARSONVAL SENSITIVE RELAYS) AVAILABLE FOR OTHER USES

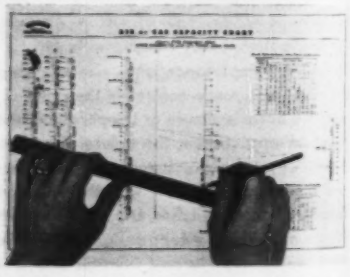
ASSEMBLY PRODUCTS INC.
TEMPERATURE CONTROL DIVISION
Chagrin Falls, Ohio. U. S. A.

the resistor element, which provide practically pure resistance for use a-c. bridges and standards.' —H. M. Parshall, Leeds & Northrup Co.

1930. "The Sheffield Visual Gage . . . first frictionless optical comparator made in the U. S. . . . used for checking master and production gages, purchased parts, work in process, for final inspection, [etc.] . . . The one shown was built for Ford Motor Co. and used for many years before its presentation to the Smithsonian Institution."—C. W. Hamilton, Sheffield Corp.

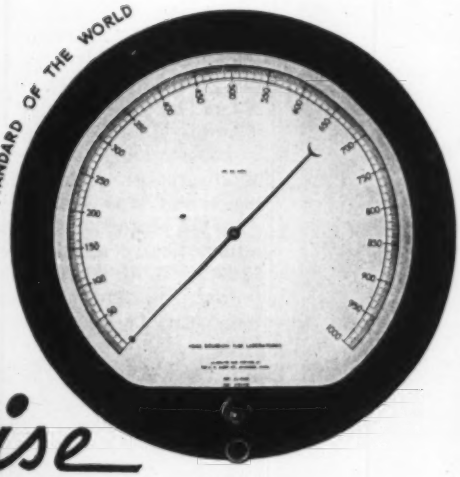


1930. "The Jones Conductivity Bridge, based on a circuit developed by Dr. Grinell Jones, was introduced by I. N. This bridge brought a new order of high precision to a-c. measurements of electrolytic conductivity."—H. M. Parshall, Leeds & Northrup Co.



1930. "Fisher Capacity Alignment Charts placed emphasis on the importance of proper sizing of valves, and provided a simple method of accurate sizing."—J. J. Mullen, Fisher Governor Co.

1930. "Leslie 'Type R' and 'D' Thermostats for use with air, gas, clean water or light oil as the operating medium provided accurate temperature



Heise

STANDARD FOR TESTING OTHER GAUGES

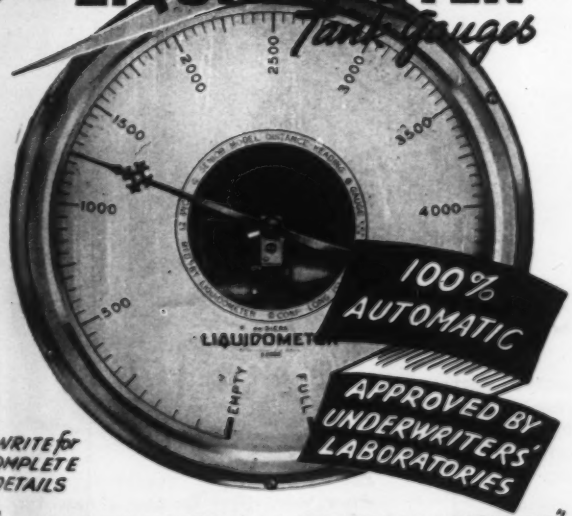
Recognized as the standard for testing pressure readings with dead weight accuracy, Heise Extreme Precision Gauges provide the quickest reliable way of testing: (1) new ordinary gauges, (2) inspector's gauges, (3) for faster results where dead weight testers have been used.

RANGE FROM 0-15 TO 0-20,000

8½" DIAL.....151.80
12" DIAL.....172.80 & 165.60
16" DIAL.....201.20 & 194.00

HEISE BOURDON TUBE LABORATORIES
BROOK ROAD NEWTOWN, CONNECTICUT
IN COLLABORATION WITH THE A. H. EMERY COMPANY

AS QUICK AS A FLASH YOU CAN KNOW THE EXACT MEASUREMENT OF YOUR VALUABLE STORED LIQUIDS With LIQUIDOMETER Tank Gauges



WRITE for COMPLETE DETAILS

"LIQUIDS WORTH STORING ARE WORTH MEASURING"

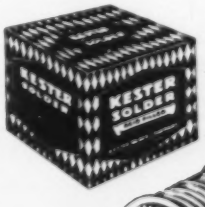
THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

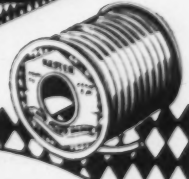
IT'S KESTER
For Every
SOLDERING OPERATION

Increase your soldering efficiency with KESTER CORED solders. Their dependability, uniformity and pureness gives you the utmost speed in every type of soldering operation.

Use Kester ACID-CORE solder for general work; KESTER ROSIN-CORE solder for all electrical work. Be sure with Kester.

It's Pure
It's Uniform
It's Kester

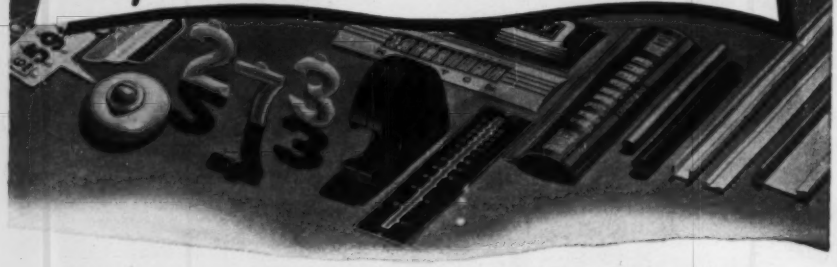




KESTER SOLDER

KESTER SOLDER COMPANY
4216 Wrightwood Avenue, Chicago 39, Illinois
EASTERN PLANT: NEWARK, NEW JERSEY • CANADIAN PLANT: BRANTFORD, CANADA

HOPP OFFERS 7
Dependable Plastic Services



Put your plastic product or part needs in our skilled, experienced hands

- **EXTRUSION MOLDING** Continuous lengths in any form.
- **FABRICATING** Variety of sheets, flexible or rigid, wide color range.
- **INJECTION MOLDING** Parts or products molded to specified shape.
- **PRINTING** Our specialty has been printing where extremely close register is imperative.
- **LAMINATING** Layers of transparent plastics, sealing hermetically any printed surface.
- **DIE CUTTING** To any shape, done on our own premises.
- **FORMING** Sheet plastics formed to desired shape.

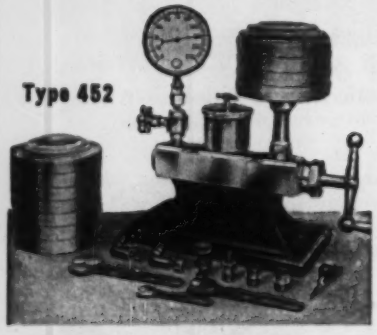
Investigate our COMPLETE Plastics Facilities

PIONEERS HOPP in PLASTICS

HOPP PLASTICS a division of THE HOPP PRESS, Inc.
460 WEST 34th ST., N. Y. 1, N. Y. · EST. 1893 · TEL. BRYANT 9-1803

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in ten ranges, to 5000 lbs maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

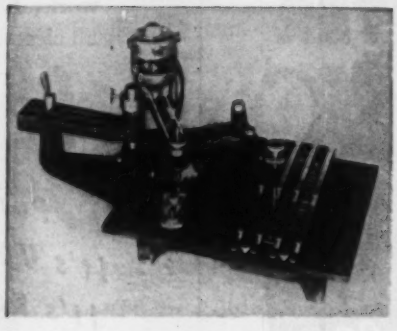
The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

—MICO— ENGRAVER



For lettering panels of steel, aluminum, brass, or bakelite, or for making finished apparatus.

Attachments adapt it to small or large work on flat or curved surfaces.

Excellent engraving can be produced by an inexperienced operator.

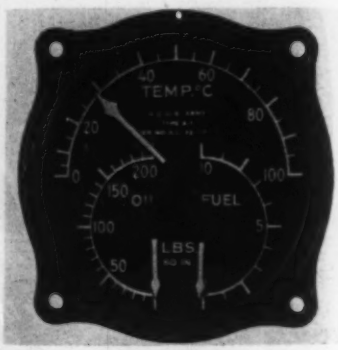
Widely used for production as well as occasional engraving.

Catalogue on request

MICO INSTRUMENT CO.
86 TROWBRIDGE STREET
CAMBRIDGE, MASS.

regulation with an extremely rugged instrument . . . featured the bi-metallic principle and a double-effect pilot valve design for quick response. [Same year] 'Class LT' Regulating Valve for use with air- or water-actuated instruments . . . outstanding because it responded to small pressure changes from the instrument and was relatively friction-free . . . the first valve for this service to automatically adjust the outlet steam pressure in direct relation to the operating air pressure." — John S. Leslie, President, Leslie Co.

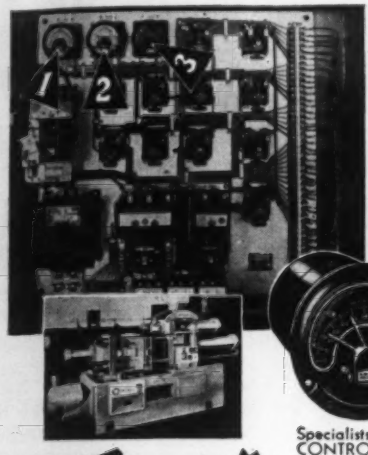
1930. "Permutit abandoned the original German design of 'Ranarex' . . . New design was particularly adapted to flush panel mounting . . . reduced in size and lightened in weight . . . popular indicator dial was retained but the recording mechanism was changed to incorporate a 24-hr. 8" circular chart . . . Another great improvement . . . non-corrosive Bakelite for impellers and impulse wheels. Stronger suction of the instrument was provided by increasing the diameter of all wheels in its mechanism by about 30%. . . . An interesting development in the use of 'Ranarex' about this time was its application to marine use. . . . ability to withstand high temperatures, shock, and the rolling and pitching of vessels at sea. . . ."—K. F. Urquhart, for The Permutit Co.



1930. "American Stationary Tachometers were first to use a new type of contoured weights on the governor resulting in uniformly graduated dials. Easier reading of the dial and greater accuracy. . . . Ashcroft introduced an Engine Gage Unit for aircraft service which incorporated oil temperature, oil

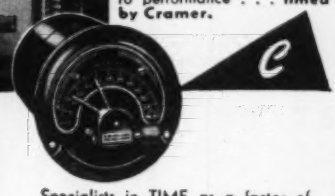
TIME as a factor of CONTROL in Industry

NEW ROCKFORD 4 - FUNCTION MOLDING MACHINE FOR THERMOSETTING PLASTICS ... *timed by Cramer*



Measuring, preforming, preheating, molding — the four functions of molding thermosetting plastics combined in one machine! A development of the Rockford Machine Tool Co., all movements are hydraulically powered, electrically controlled . . . automatically timed through the complete operating cycle by Cramer Time Delay Relays.

Another product where dependable control is essential to performance . . . **timed by Cramer.**



Specialists in TIME as a factor of CONTROL, Cramer has developed a wide range of devices for a great variety of commercial and industrial duties. If the performance of your product depends on precision timing, consult Cramer

Cramer

THE R. W. CRAMER COMPANY, INC.
Box No. 5, Centerbrook, Conn.

ICR48

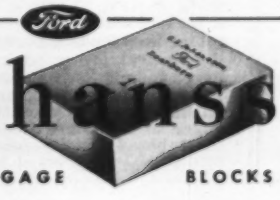
ITEMIZED CERTIFICATE OF INSPECTION
Shows you which blocks, if any, are inaccurate and how much. Issued with each inspection.

IT MAY be that long service or careless handling has worn many of your most-used gage blocks until they're *way out of tolerance. It pays to know which blocks need reconditioning or replacement. Send your whole set of blocks in to Ford for inspection. Cost is only 25 cents a block for "A" and "B" blocks up to one inch, or for each inch of length of longer blocks. (Minimum charge $1.) Details, methods, costs, of reconditioning your gage blocks, including the Ford chrome-plating method, sent on request. Write—

FORD MOTOR COMPANY • JOHANSSON DIVISION
3604 Schaefer Road, Dearborn, Mich.

Ford

Johansson



GAGE BLOCKS

You can depend upon MOELLER ACCURACY

. . . to safeguard PROFITABLE PRODUCTION

. . . for Moeller Thermo-wells, Thermo-couple protecting wells and separable sockets are actually weapons of industry. They help conquer the baffling problems of scientifically testing temperature readings and recordings, as well as making possible the most intricate types of thermometer installations.

Produced on specially designed equipment, these precision parts are drilled true and are concentric with the outside diameter. The surfaces are machined and tooled to the closest tolerance to permit maximum speed of response to temperature changes. Made in various alloys.

Further details may be found in Moeller catalogs and literature covering . . .

INDUSTRIAL, LABORATORY AND RECORDING THERMOMETERS
THERMOSTATS • HYGROMETERS • HYDROMETERS • PSYCHROMETERS
and MARINE SPECIALTIES

MOELLER INSTRUMENT COMPANY
132nd STREET and 89th AVENUE — RICHMOND HILL, NEW YORK
OFFICES IN PRINCIPAL CITIES

for INSULATION RESISTANCE Measurements

Vibrotest IS BEST

36 MODELS FOR EVERY APPLICATION

RANGES UP TO 50,000 MEGOHMS

SIMPLE PUSH BUTTON OPERATION

For every insulation resistance measurement the versatile Vibrotest is far superior in its field. Ruggedly constructed throughout; large easy to read meter scale; stable self-contained power source; fully guarded—no erroneous readings due to surface leakage even in extremely humid conditions. Ranges up to 50,000 megohms at 500 VDC or 1000 VDC potential, with ohmmeter ranges covering a wide range. Most models include three convenient ranges of A.C. and D. C. volts.

Write for Bulletin 208

Also available "Vibroground" ground resistance testers—cable fault locators—"Hypot", insulation breakdown testers—ammeters—ohmmeters—soil resistivity meters—limits bridges—current transformers.

ASSOCIATED RESEARCH, Incorporated

"Precision instruments since 1936"

233 SOUTH GREEN STREET CHICAGO 7, ILLINOIS

DIFFERENTIAL PRESSURE INDICATOR MODEL 181

- 6" HIGH VISIBILITY DIAL
- 0-50 INCHES OF WATER UP TO 0-200 P.S.I.
- UNIVERSAL MOUNTING
- RUPTURE-PROOF BELLOWS UNIT

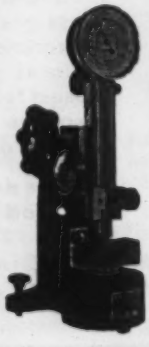
Write for Bulletin 181-1

BARTON INSTRUMENT COMPANY

3500 UNION PACIFIC AVE.
LOS ANGELES 23, CALIF.

HARDNESS TESTING...

done WITH NO METAL HAZARDS. The SCLEROSCOPE has done it for the past 40 years.



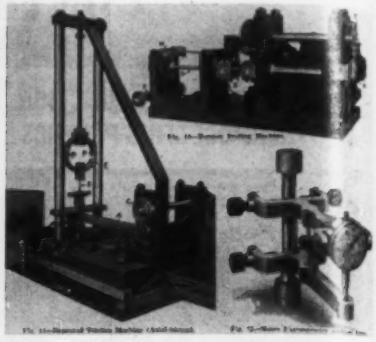
In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

9025 Van Wyck Ave., Jamaica 2, N. Y.

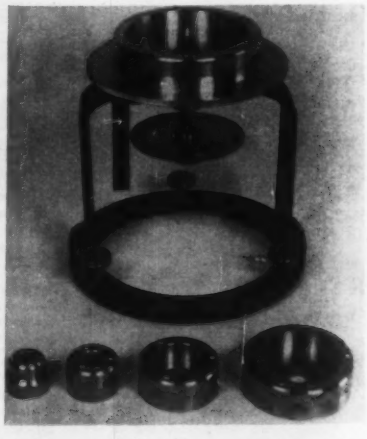
pressure and fuel pressure readings on one dial. (See illustration.) . . ."—S. Goodwin, Manning, Maxwell & Moore.



1930. "The Moore Extensometer was added to the extensive line of metal testing machines which had been developed and placed on the market for the preceding ten years, beginning in 1920."—J. Burton Hayes, Hayes Scientific Appliances.

1930. "Fuel Flow-Air Flow Ratio Meter introduced. . . . simplified the problem of obtaining the correct amount of excess air for gaseous or liquid fuels."—E. B. Bossart, Bailey Meter Co.

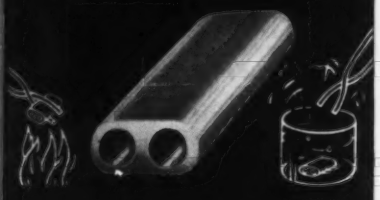
1930. "1927 had seen the entrance of the Sperry Gyropilot into the field of marine navigational instruments. (. . . utilizes the true-north indication of the Gyro-Compass to steer the vessel automatically on any desired course.) In 1930 a Two-unit Gyro Pilot was developed, featuring an independent power unit. . . ."—C. H. Jones, Sperry Gyroscope Co.



1930. Spherometer. "This instrument developed at the NBS consists, in principle, of a sphereometer of the usual micrometer-screw type *inverted* and supported on ball bearings by a convenient stand which permits the entire measuring system to rotate as a unit. To make a measurement, the spherical surface to be tested is placed in position on the ring and the central screw advanced until it is believed to be in contact with the surface, after which the entire measuring system is given an abrupt partial rotation by applying the finger to the knurled edge of the spherometer table. If the weight of the lens being measured is supported by the ring, the lens will rotate with it. On the other hand, if the

Be Certain WITH "SERV-RITE"

THERMOCOUPLE INSULATORS



This Gordon Thermocouple Insulator, heated red hot and plunged into cold water, came out just as good as new

Available only through GORDON, Serv-rite Thermocouple Insulators are made to stand the gaff of excessive thermal shock far above normal requirements.

For sturdy and reliable thermocouple insulator performance to meet peak production needs — Specify Serv-rite...a Gordon development backed by 32 years' experience in supplying industry with insulators that last longer and give better results.

Serv-rite Thermocouple Insulators—in any type or size—can be supplied immediately from Gordon's large stocks in the Chicago and Cleveland Plants. Remember—you can always distinguish **Serv-rite** Insulators by their *tan* color.

Fish Spine Beads	Asbestos String
Asbestos Tubing	Single Hole
Double Hole Round	Double Hole Oval

CLAUD S. GORDON CO.

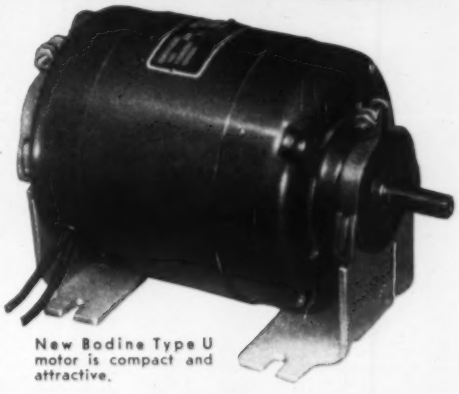
Specialists for 32 Years in the Heat Treating and Temperature Control Field

Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 7016 Euclid Avenue • Cleveland 3, Ohio

DEPENDABLE POWER FOR INSTRUMENT APPLICATIONS

Newest addition to the Bodine family of quality fractional horsepower motors is this Type U motor. The basic engineering which produced this motor is an example of Bodine precision technique applied to mass production.

This new motor is available on large-quantity orders only, in 1/20 and 1/15 horsepower at 1725 rpm, and 1/30 horsepower at 1125 rpm. Attractive gray Hammeroid finish, generous oil reservoirs around sleeve bearings, resilient mounting rings, thermal overload protection, high efficiency, and quiet operation are some of its desirable characteristics. Early delivery. Bodine Electric Co., 2244 West Ohio Street, Chicago 12, Illinois.



New Bodine Type U motor is compact and attractive.

BODINE

FRACTIONAL HORSEPOWER **MOTORS**

RAWSON METERS

MULTIMETERS and REGULAR METERS
AC and DC types, high accuracy, multiple ranges.
2 microamperes to 1 ampere DC.
2 milliamperes to 3 amperes AC.

ELECTROSTATIC VOLTMETERS
Ranges 150-v. to 35,000-v AC or DC.
Resistance exceeds million megohms.
Can measure static electricity.

FLUXMETERS
Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

WATTMETERS
High sensitivities, low power factors. New types soon to be announced.

Special apparatus built to order

Write for details and estimates

RAWSON ELECTRICAL INSTRUMENT COMPANY

112-b Potter St. Cambridge, Mass.

Representatives
CHICAGO LOS ANGELES NEW YORK CITY

Automatic ELECTRIC PRODUCTS

TIME SWITCHES
Ruggedly constructed *Automatic* Switches have visible dial in tamper proof compact cabinet . . . pure silver contacts . . . 2 to 24 "on" and "off" operations. For any load . . . for every installation an *Automatic* time switch or Interval Timer will deliver superior performance.

Synchronous or Manually Wound

FLASHERS
Automatic heavy duty, motor driven Flashers available in circuit arrangements for every conceivable effect. Pure silver contacts. Models for any load or purpose.

Alternates *Chasers* *Spellers*

RELAYS
Automatic manufactures a complete line of dependable relays for industrial, business machines, radio, electronic and many other uses . . . open, or can type with tube-base, plug-in features.

Consult our Engineering Department

WRITE FOR SPECIFICATIONS AND INFORMATION TODAY

In Switches, Flashers and Relays where dependable performance is paramount, look for the "Diamond Seal for Diamond Quality".

WRITE TODAY!

AEMCO *Automatic Electric* MFG. CO.

58 STATE ST., MANKATO, MINNESOTA

STANDARD BRAND LINES

RCA • AMPERITE • SIMPSON-JENSEN
STANCOR • OHMITE • SHURE • BLILEY
DUMONT • IRC • TRIPLETT • SPRAGUE
and hundreds of other well-known brands
COMPLETE STOCKS

New! Complete!

Concord Radio Catalog

LOWEST PRICES on Everything in... RADIO·TELEVISION·RADAR ELECTRONIC EQUIPMENT

- Thousands of items for every Radio and Electronic need.
- Special Bargains—money-saving values in top quality Radio Parts.
- Immediate delivery from huge stocks at Chicago and Atlanta.

MAIL COUPON FOR FREE COPY

CONCORD RADIO CORPORATION
CHICAGO 7 — 901 W. Jackson Blvd.
ATLANTA 3 — 265 Peachtree St.
Downtown Chicago Branch - - 229 West Madison St.
LAFAYETTE RADIO CORP.

Concord Radio Corporation, Dept. T-18
901 W. Jackson Blvd., Chicago 7, Ill.
Yes, rush FREE COPY of the comprehensive new Concord Radio Catalog.
Name.....
Address.....
City.....State.....

Thermocouple LEAD WIRES

QUALITY of thermocouple and extension lead wires depends on careful processing controls. We have these controls. Our skill, high standards of accuracy and complete insulating facilities produce pyrometer wires that will meet your most rigid requirements.

Our Iron Constantan, Chromel Alumel, Copper Constantan wires, stranded and solid, are made in many sizes and types and are available with plastic, asbestos, cotton or fibreglas insulations; also furnished in standard resistances for specific lengths.

Certificates of Calibration, *giving temperature deviations from standard EMF values, are supplied with all wire for thermocouples; and will be furnished, upon request, with lead wires.*

Send for Lead Wire Bulletin 30 or Complete Catalog Describing . . .

THERMOCOUPLES • ACCESSORIES
QUICK COUPLING CONNECTORS
LEAD WIRES • PROTECTION TUBES

Thermo ELECTRIC CO.
FAIR LAWN, N.J.

VANE TRANSMITTERS

by AUTOFLIGHT

FOR ANGLE OF PITCH AND YAW

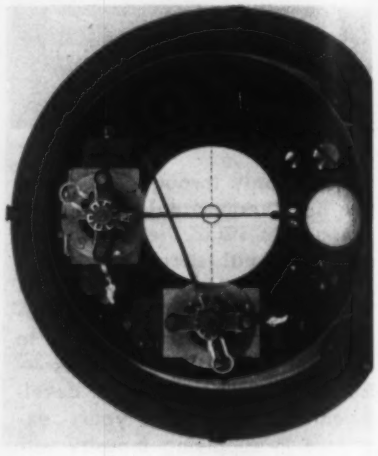
Compact units consist of two Microtorque Potentiometers, each geared to a vane and enclosed in a steel tube for mounting to standard pitot tube mast. Various resistance ranges from 100 to 20,000 ohms; ¼° accuracy.

Write for detailed information.

AUTOFLIGHT
AUTOFLIGHT INSTRUMENTS
A Division of C. M. Clarke & Co. Inc.
285 WEST COLORADO ST.
PASADENA 1, CALIFORNIA

weight is largely borne by the cent... upon rotation the lens will stand... there will be relative rotation be... lens and ring. The setting is conside... when this relative rotation between... ring is incipient. This is an ast... sensitive and convenient method o... contact. Readings can be repeate... spread of approximately one mic... On the upper annular surface of ea... ometer ring there is a v-groove... three balls . . . are spaced 120° an... by retaining strips which leave the... to rotate and to assume the lowern... tion possible in the v-groove. This... spherometer ring retains its calibra... resists accidental damage much be... a ring with a sharp knife-edge. . . . This spherometer has proved particularly con... venient for shop use. The accuracy is lim... ited by the accuracy of the screw and pos... sible variation in thickness of the layer of lubricant between screw and nut. The in... strument was designed by Mr. F. A. Case."— Hugh Odishaw, National Bureau of Stand... ards.

1930. "Drop Weight Surface Tension Apparatus by Harkins, for determining surface tension quickly, accurately and under controlled temperature conditions." — H. E. Brown, W. M. Welch Mfg. Co.



1930. Aircraft Instrument Landing Indicator. "This instrument, devised at the NBS, was designed for use with the blind landing system for aircraft then under development by the Bureau. Basically, the system as originally developed comprised three elements to indicate to the pilot the position of the aircraft as it approaches and reaches the instant of landing: (1) two overlapping radio beams having different modulation frequencies which produce the runway localizer course in space, where the two modulation frequencies are of equal intensity (2) an inclined UHF radio beam used in such a manner that by following a zone where the field strength is always the same, the pilot follows a safe glide path; (3) marker beacons giving localized signals which indicate longitudinal position along the line of approach. The dual-pointer instrument shown was designed to give a visual indication to the pilot of his position in space with respect to the runway localizer and glide-path courses. It consists of two 0-500 microammeter movements mounted at right angles in a single case. The vertical pointer indicates deviations to the right or left of the runway course; the horizontal pointer indicates movements above or below the proper glide path. The pilot has only to keep the point of intersection of the two needles within the small index circle in the center of the instrument . . . The system has passed through many hands since its early stages of development at College Park, Md., nearly 20 years ago, yet blind landings are being made today substantially as pilot Boggs made his first one on September 5, 1931. The system, in slightly modified form, is now known as the ILS . . . has been

adopted by the Provisional International Civil Aviation Organization. The dual-pointer instrument landing indicator has become standard equipment on all aircraft equipped to use the ILS."—Hugh Odishaw, National Bureau of Standards.

1930. "Several notable achievements: (1) The 'Protectoglo,' a flame safety device . . . using the principle that a flame conducts electric current . . . an electrode in direct contact with the flame which thus becomes part of a relay circuit that keeps the fuel valves open. . . . (2) The Area-type Flowmeter filled a long-felt need for a device to measure the flow of heavy oils, tar, pitch, and other viscous or corrosive fluids. . . . With inductance bridge circuit . . . the Brown area flow meter opened an era for the long-distance transmission of flow measurement and control of viscous and corrosive fluids. Today virtually every oil-fired open-hearth furnace in the U. S. is equipped with this type of flow meter. (3) Successful application of cascade, or metered, control as conceived by Brown engineers . . . using the temperature controller to adjust the set point of the flow controller which regulates the fuel valve . . . In like manner, cascade control can now be used to eliminate any two variables. (4) The de Florez System of Remote Manual Control for the operation of valves . . . enabled operators to turn valves remotely located and, in effect, 'feel' their response. With ordinary motor-controlled valves . . . valve breakage etc. often resulted. . . . With the de Florez System, . . . the Selsyn receiver which drives the valve will move only in simultaneous response to movement of the remotely located Selsyn transmitter."—C. C. Roberts, Brown Instrument Co.

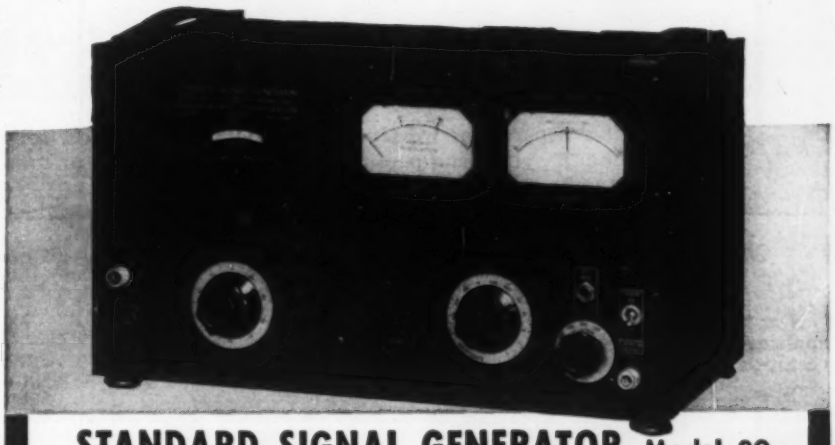
1930. "The Kimble 'Shadowless Bottom' for colorimeter tubes was developed. (Formerly, the tubes were blown in a mold and the outside bottom was ground and polished. . . .)"—J. J. Moran, Kimble Glass.

To Be Concluded

So much material is coming in so long after the dead-line, that we cannot further delay going to press with this issue—which already has been delayed excessively. The remaining historical items will appear in the February issue.

—*Instruments Publishing Co.*

Instrument Technician—opportunity for recent Mechanical Engineering graduate or man with comparable experience. To work for large brewery in Newark, New Jersey. Calibration of Laboratory Instruments. Salary good. Write stating age and experience. Box 143, Instruments Publishing Co., 1117 Wolfendale Street, Pittsburgh 12, Pa.



STANDARD SIGNAL GENERATOR Model 80

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.

OUTPUT: 0.1 to 100,000 microvolts.
50 ohms output impedance.

MODULATION: A M 0 to 30% at 400 or 1000 cycles internal.
Jack for external audio modulation.
Video modulation jack for connection of external pulse generator.

POWER SUPPLY: 117 volts, 50-60 cycles.

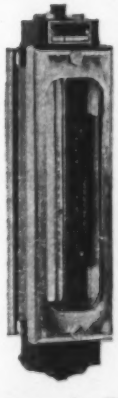
DIMENSIONS: Width 19", Height 10¾", Depth 9½".

WEIGHT: Approximately 35 lbs.
Suitable connection cables and matching pads can be supplied on order.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

THE FULL-VIEW ROTAMETER



gives research flexibility!

The Full-View Rotameter provides extraordinary help to the research or pilot plant worker for flow rate measurement. Four pyrex metering tubes of different capacities will fit into one rotameter case. Also each tube has four floats that have individual ranges. Thus with one frame, four tubes and sixteen floats, a liquid range of 0.2 c.c. to 200 c.c. per minute and a gas range of 10 c.c. to 7000 c.c. per minute may be obtained. With brass or steel end fittings, the price of all this equipment is only $101.00. With type 304 stainless steel fittings, the price is $130.00. Delivery from stock. A set up like this one on hand will give you the equipment to measure *immediately* any flow rate requirement that may come up in your research. For full information, write

BROOKS ROTAMETER CO.
BOX A-5148 LANSDALE, PA.

PORTABLE INDICATOR PYROMETER

Built with the Engelhard frictionless galvanometer eliminating bearings, pivots, etc. with its resultant friction and maintenance. A precision instrument strongly built to stand rough service. Nine standard scales. Also special scales available.

Write for descriptive Bulletin 400.

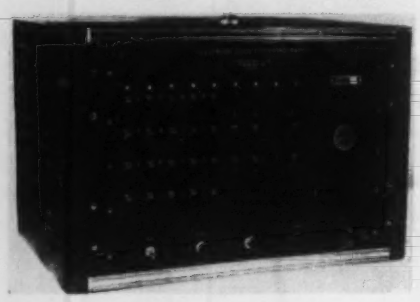
Charles Engelhard, Inc.
850 Passaic Ave., East Newark, N. J.

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 91

Microsecond-resolution Chronoscope

New "Model 450 Interval Timer," for applications which require an extremely accurate time interval measurement,



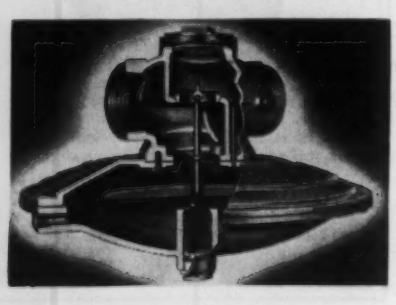
will measure intervals in steps of 0.625 microsecond; will register, directly, intervals up to 1 second. Longer periods can be registered by using an external counter to register number of times the cycle is repeated. "Model 450" is actuated by positive pulses which can be easily derived from detectors such as photoelectric equipment and closing contacts. Time base consists of a 1.6-Mc. crystal oscillator. Oscillator, electronic switch and counter decades are made up as individual units which plug into chassis. Indication is by means of neon indicator glow lamps.—*Potter Instrument Co., Inc., 136-56 Roosevelt Ave., Flushing, New York.*

Please mention number 101 when filling out card

Atmospheric Pressure Controller

New "Series 18 Soft-seat Atmospheric Regulator" features tight shut-off when demand for gas flow ceases by incorporating a soft synthetic rubberized fabric facing on regulator valve head. Thus, close control can be realized at low gas flow. Regulator furnishes gas at atmospheric pressure and requires, as supply, gas pressures of 2 to 16 oz. Although designed for supplying atmospheric gas to pre-mix systems, single valve control also can be had with nozzle-mix systems by connecting vent on regulator into line supplying air to burner on downstream side of control valve. Both pre-mix and nozzle-mix systems are assured proportional air-gas ratios over entire regulator capacity range. Made in sizes ¾", 1", 1¼", 1½", 2", 2½", and 3", new regulators have capacities ranging up to 16,000 cfh. of natural gas or 19,000 cfh. of mfd. gas. —*The North American Mfg. Co., 4455 East 71st St., Cleveland 5, Ohio.*

Please mention number 102 when filling out card



Accelerometer Pick-up

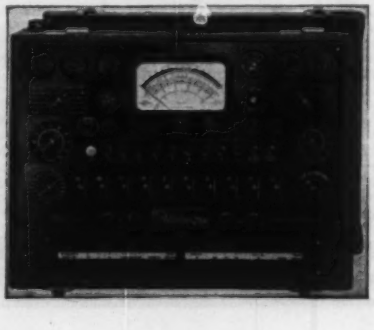
New "Linear Acceleration Transmitter" converts longitudinal acceleration into linearly proportional electrical output, is said to be highly insensitive to quadrature accelerations. Mass weight is magnetically damped so that optimum performance is obtained regardless of temperature or altitude. Ranges vary up to ±25*G*; higher ranges on application. Resistances range from 100 to 20,000 ohms. Dimensions 6⅞" long and 1⅛" diameter; weight 6 oz. including mounting brackets. Another version of same instrument is "Maximum Indicating Accelerometer" which can be expelled from aircraft or missile, recovered, read, reset, and used again.—*G. M. Giannini & Co. Inc., Pasadena, Calif.*

Please mention number 103 when filling out card

Tube and Set Tester with Automatic Reset

New "Model 445" tube and set tester incorporates "Model 260" 20,000 ohms per volt set tester which offers a variety of useful ranges; and a tube tester of plate conductance type with dial indicating percentage of rated plate conductance. This can also be considered as percentage of mutual conductance since, in most cases, amplification factor remains constant. Automatic reset mechanism returns all switches to normal at end of each test. Socket for all types of tubes are provided, including new nine-pin miniature, also sub-miniature as used in hearing aids, etc.—*Simpson Electric Co., 5216 Kinsie St., Chicago 44, Ill.*

Please mention number 104 when filling out card



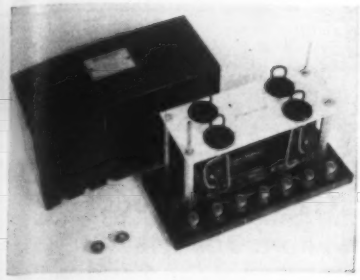
Foundry Thermocouples

New "Thermo-Tips" are announced as "a complete line of enclosed thermocouples for general foundry use, interchangeable with existing equipment." It is said that unique fabricating methods permit them to be constructed inexpensively in one piece in any length or shape. Longer thermocouples eliminate difficulties with burned handles and frozen set screws. "Thermo-Tips" are supplied in standard 18", 24" lengths, straight or with 45° or 90° bends, in 16-gage matched Chromel-Alumel elements. Shorter lengths also available. For special purposes and where higher sensitivity and faster temperature indication are required, matched thermocouple wires of 20-gage size or of iron-Constantan can be supplied. — *Industrial Instrument Service Co., 2785 Slauson Ave., Huntington Park, Calif.*

Please mention number 105 when filling out card

Phase-shifting Transformers for Meter Conversion

New line of adjustable phase-shifting transformers that will convert standard watthour meters to kva-hour meters by displaced-voltage method shift voltages by 0°, 30°, 45° and 60° corresponding to 100, 86.6, 70.7 and 50 per cent power factor respectively, depending upon position of movable plugs inserted in radio-type sockets built into units. Principle: by shifting phase angle of voltage a proper amount, any



watthour meter can be made to read kva-hours. Thus, if p-f. of load is known to be about 87%, shifting voltage by 30° causes watt-hour meter to read kva-hours directly. Registration errors in no case exceed 2% so long as phase angle of load is within 11° of tap setting. Five types: "K-12" for 2-phase 3-wire connections; "K-13" for 3-phase 3-wire; "K-14" and "K-18" for 3-phase 4-wire; "K-17" for 3-phase 4-wire delta connections.—*Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.*

Please mention number 106 when filling out card

Instruments for Measuring Germicidal Energy

Three new germicidal energy measuring instruments designed to aid in proper installation and maintenance of germicidal lamps are announced.

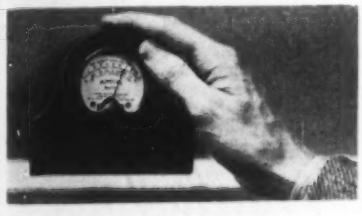


Fig. 1

(1) New Germicidal Reflectometer measures amount of germicidal energy reflected by walls and ceiling, or by materials suitable for reflectors. It should help engineers to design germicidal systems which do not reflect excessive amounts of germicidal energy into eyes and upon skin of people in the room. It comprises a U-shaped 4-watt 115-volt GE germicidal lamp, a microammeter and two light-sensitive cells equipped with filters. Calibrated output meter measures only germicidal energy reflected by materials being tested; scale reads directly percent of germicidal energy reflected by test surface.

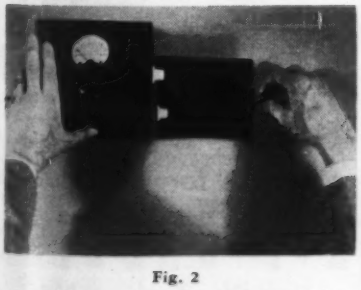


Fig. 2

(2) New Germicidal Wattmeter shows directly germicidal output of a lamp in service; employs two light-sensitive cells equipped with filters. In use, it is placed in direct contact with germicidal lamp without moving latter from its reflector. It is said to be the first practical instrument developed for determining whether a lamp is operating efficiently, or should be replaced.

Fig. 3

(3) New Germicidal Ultraviolet Intensity Meter measures intensity of germicidal ultraviolet anywhere in a room, as a common light meter measures amount of visible light at a given time and location. It consists mainly of a cadmium phototube and an amplifier; is entirely insensitive to natural or artificial light; can be used in a lighted room without being affected by visible radiation.—*Lamp Department, General Electric Co., Nela Park, Cleveland 12, Ohio.*

Please mention number 107 when filling out card

5000-lb. Testing Machine

New type of "Baldwin-Tate-Emery" testing machine has been designed primarily for precision testing of plastics, rubber, non-ferrous metals, textiles, fibers and similar materials. Distinguishing features are said to be continuously-variable 400:1 positive speed range, great horizontal rigidity, complete elimination of backlash and high accuracy even in lowest ranges. Maximum capacity is 5,000 lbs. Loading is by a mechanical screw system, driven by a variable-speed motor with General Electric "Thymotrol" control. Speed of loading is steplessly variable from 0.05″ to 20″ per minute can be held constant within ±2%. In weighing system, Emery capsule used in most testing machines of this make replaced by a 100:1 mechanical compound lever using flex plates instead of knife edges at load points and fulcrums. Specimen is pulled, compressed or flexed at short lever end; long end operates force balance mechanism of indicating system. Except for this difference in operation of force balance mechanism, indicator is, in general, standard Tate-Emery type. Four ranges are provided: 5,000 lbs. in 5-lb units; 0-1,000 lbs. in 1-lb. units; 0-200 lbs. in units of 0.2 lb.; and 0-50 lb. in units of 0.05 lb. Maker's standard guarantee of indication accuracy applies: better than ½% of reading or 0.1% of range, whichever is greater. Range change is by conventional rotating mask, together with use of iso-elastic spring units especially designed for quick replacement. Zero adjuster, range selector, maximum dial hand, load rate pacing disk, and other equipment usually found only on larger hydraulic machines, are included. New machine is designed to permit use of maker's standard accessories such as Templin grips, Baldwin extensometers, compressometers, deflectometers, subpresses and flexture tools, as well as special grips required for various materials. — *The Baldwin Locomotive Works, Philadelphia 42, Penna.*

Please mention number 108 when filling out card

Pocket Microscope

New "Pen" microscope, no larger than a pocket fountain pen, is easily adjustable to give 40×, 50× or 60×

magnification, has satin nickel finish, can be quickly employed for examining minute detail in shop, office, laboratory or at home, comes with leather case.—*E. W. Pike & Co., Elizabeth 13, N. J.*

Please mention number 109 when filling out card

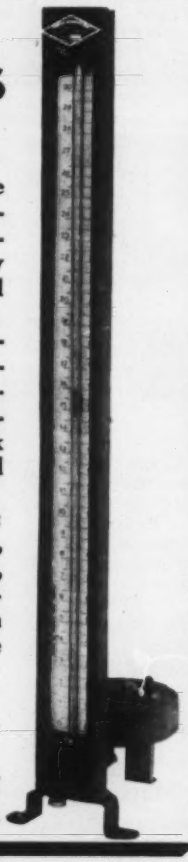
Cueing Attenuators

New cueing attenuators feature a special switching mechanism to transfer attenuator input to a pair of separate output terminals for cueing purposes, facilitate program switching and fading in "on cue" without any increase in the diameter of the attenuator. Any standard Shallcross ladder, bridged T, straight T, or voltage-divider may be equipped for cueing action, including units as small as 1¾″ diam.—*Shallcross Mfg. Co., Collingdale, Penna.*

Please mention number 110 when filling out card

TRIMOUNT MANOMETERS

for Every Industry



Trimount Manometers are widely used to measure differential and absolute pressures as well as rate of flow in equipment in the field and in the laboratory.

Trimount's line includes U-Tube and Well Type Manometers, Inclined Manometers, Draft Gauges, Indicating Flow Meters, Tank Liquid Level Gauges, and Micro Manometers.

Electronic devices include: Dynamic Pressure Gauges, and a new Carrier System, Liquid Level Controls, Electronic Pressure Controls, Bin Level Controls, and Pressure Cutoff Switches.

Write for literature.

TRIMOUNT INSTRUMENT COMPANY

37 W. Van Buren St., Chicago 5, Ill.

Mechanical Measurements by Electrical Methods

Serialized in *Instruments* under the title

"Electric Gaging Methods"

By HOWARD C. ROBERTS

Special Research Associate Professor of Civil Engineering, University of Illinois *(for many years in Research Lab., A.R.A.).*

Typical of the comments received while this book ran as a serial in *Instruments:*

". . . I appreciate the thoroughness with which the subject is being treated." "We are sure that your articles will be widely read, for it is a subject certainly in need of the correlation you are giving it." ". . . I am glad to find that you have done so exhaustive a job on the subject." "We have made reproductions of these articles and have them in our files for reference as we feel that much valuable information is contained therein." "These articles would be of great help to us in our scientific research work since they introduce some novel measurement techniques."

ORDER THIS UNIQUE BOOK NOW

Instruments Publishing Co.
1117 Wolfendale St., Pittsburgh 12, Pa.

Enclosed is $_____ for _____ copies of Roberts "Mechanical Measurements by Electrical Methods" at $3.00 each, postpaid.

Name _____

Address _____

Check, Money Order or Cash Must Accompany Order

High precision OPTICAL PARTS for Research, Development or Production.

•

PARABOLIC or SPHERICAL Mirrors.

•

LENSES, PRISMS or related components for your visual, photographic or electronic requirements.

•

Natural or Synthetic CRYSTAL OPTICS.

•

Complete optical INSTRUMENTS.

•

Vacuum Coating of Optical Parts.

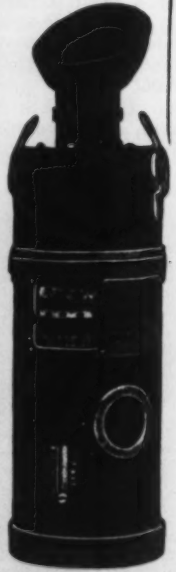
•

John Unertl Optical Co.

3551-3555 East Street
Pittsburgh 14, Penna.

PYRO THE SIMPLIFIED OPTICAL PYROMETER

SAVE TIME AND MONEY!



By using PYRO, a self-contained, DIRECT READING, sturdy unit made to stand rough use. It is absolutely accurate and dependable, and quickly pays for itself.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten Iron and steel when measured in the open.

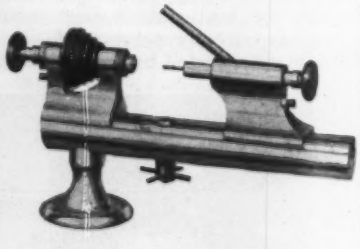
Stock ranges 1400° F. to 6000° F.

Bulletins on PYRO Optical, Radiation, Surface and Immersion Pyrometers on request.

THE PYROMETER INSTRUMENT CO.
Plant & Lab
103-107 LAFAYETTE ST., NEW YORK, N. Y.
In Canada, Sales and Repair Laboratory: Dominion Flow Meter Company Limited Toronto and Montreal

Watchmaker's and Instrument Maker's Tools

Lathes— Benches, Etc.



Write for Circulars

R + P + GALLIEN

Materials—Tools—Supplies

220 W. FIFTH AVE.
LOS ANGELES 13, CALIFORNIA

JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
I.S.A. National Office, 1117 Wolfendale St., Pittsburgh 12, Penna.

I.S.A. Officers

Paul G. Exline, Pres. — Herbert H. Barnum, V. Pres. — Hugh E. Ferguson, Treas.
Carl F. Kayan, 1st V. Pres. — H. C. Frost, V. Pres. — Richard Rimbach, Exec. Sec'y.
Fred H. Trapnell, V. Pres.

Vol. 3 — January 1948 — No. 1

Editorials

Very Accurate

(A guest editorial by W. E. "Bill" Wilson, member of the Detroit Section and Editor of that Section's monthly publication, "The Detroit Recorder.")

It is well known that a thermocouple is a very accurate means of measuring temperature — but *what* temperature? The temperature of the thermocouple, and nothing else!

It depends upon the engineer, operator or some other character as to whether or not the temperature of the thermocouple is the temperature of the material being studied. The real trouble with inaccurate indications is that, more often than not, the sensitive element and the material are not at the same condition. This is true not only of thermocouples but of other measuring elements for temperature, pressure, vibration, strain and a host of other variables. This matter of making the sensing element indicate the true condition of the variable remains a perennial problem.

Many costly and accurate instruments have given years of undependable service only because someone didn't have the experience or training to see that the measuring element got placed in intimate contact with the variable under observation. This is where the instrument man is worth his salt. He is the man with the *know-how* for getting things together. He is the man who knows the answers to the problems of poor contact, restriction, line drop and other errors that cause grief.

Maybe YOU are the man who knows all the answers, but if you know only the questions, you'd better start looking for the MWTA. The purpose of the I.S.A. is to make the Man With The Answers available to YOU.

You never can tell when one of those answers will come in darned handy someday! —W. E. WILSON

On Securing Speakers

We have been asked several times recently, especially by some of the newer Sections and by some of the older but smaller Sections, to (1) suggest means of obtaining speakers for their monthly meetings, and (2) to publish a chart of the regular meeting dates of the other Sections.

Several reasons for request No. (2) have been advanced, the most common one being that it would enable these Sections to obtain speakers (or better speakers, perhaps) by scheduling those who will be visiting nearby Sections at about the same time. In other words, they feel (and properly so, we believe) that a speaker from, say Chicago, might give more consideration to requests for two, three or four consecutive engagements in the east if he could cover them all in a few days on one trip than he would to just one request or to several requests for engagements spaced widely with respect to both time and miles. This "grouping" or "circuit scheduling" would be advantageous not only to the Sections at present having difficulties in securing speakers, but to the speakers as well.

We believe this to be a worthwhile cause, and in its furtherance we have prepared such a chart, published here-

REGULAR MEETING DATES OF I.S.A. SECTIONS

SECTION	FIRST	SECOND	THIRD	FOURTH	LAST
	M T W T F	M T W T F	M T W T F	M T W T F	M T W T F
Akron	X				
Baltimore		X			
California					
Coast, Ind.	X				
Charleston	X				
Chicago	X				
Cincinnati				X	
Cleveland					X
Cumberland				X	
Detroit			X		
East, N. Y.	X				
Gulf Coast					
Kansas City				X	
Louisville					X
New Jersey	X				
New Orleans					
New York				X	
Niag. Frntr.				X	
No. Indiana			X		
Oak Ridge	X				
Ontario			X		
Philadelphia					X
Pittsburgh					X
Presque Isle					
St. Louis	X				
Sarnia	X				
South Bend		X		X	
So. Michigan			X		
South Texas	X				
Tennessee			X		
Tulsa					X
Twin Cities				X	
Washington			X		
Wayne County			X		

with; we hope it will be instrumental in helping the requesting Sections to obtain speakers more easily henceforth. This chart is based on information requested from the various Sections during the past few months, and all but a very few Sections have fixed their meeting dates and have so informed us. Some of these dates will no doubt be changed if it is necessary to do so in order to take advantage of a future program of speaker "routing." Some may be in error already because of changes since our information was accumulated. (Section Secretaries are requested to please notify us of these changes immediately so that the establishment of a definite program at any time in the near future can be based on up-to-date information.)

We know of just two attempts along the line above mentioned. The first is now almost forgotten by many Sections —it was a list of available speakers, secured by means of a questionnaire, which was prepared some years ago by INSTRUMENTS Magazine in an attempt to start a "Speaker's Bureau." This was very useful to the various individual Societies, most of them young and inexperienced at that time, and should have been, in our personal opinion, one of the first things to be revived (or revitalized) when these various Societies organized to form the Instrument Society of America. (Latest reports reaching us have it that something *is* going to be done about it soon—that, in fact, the groundwork has already been laid.)

The other flyer in this field is a program recently proposed by the Chicago Section. Chicago is fortunate in being both a geographical and an industrial hub. It has always been able to secure good speakers from almost any part of the country, and the Chicago Section provides a good many speakers from its own ranks. There are at least three Sections (with two or three more in formation) within a hundred or so miles of Chicago, almost another dozen within 300 miles and several more within 400 miles. To all of these Sections within 200 or 300 miles, Chicago is now offering its services, or "drawing power," by the simple expedient of sending them well in advance an entire season's meeting schedule.

Since this program has just gotten under way, the first listing to go out covers the schedule from January to May, 1948, only. Next season's schedule, however, which will be prepared during July, will go out as a complete schedule of meetings starting with September, 1948, and ending with May, 1949. A letter of explanation of this proposed program has been sent to the Sections around Chicago so that they may get together (by correspondence or otherwise) and arrange their meeting dates so as to take advantage of the idea if they so desire.

The proposed Chicago program schedule may not even be confirmed when it is sent out. However, it gives the participating Sections a chance to pick out whatever talks they would like to have, and get an immediate request off to any prospective speaker. When a speaker receives requests for from two to five engagements in the same area, and can cover them all in a week, he is more than likely to accept all of them—and both he and the Sections he will visit will benefit from the arrangement.

This explains why we expect to see some changes in the accompanying chart. We hope that it will assist other groups of Sections to arrange cooperative programs and take the necessary steps to set their meeting dates accordingly. It is also our hope that, since most of the I.S.A. organizational "growing pains" are now under control, this can be taken over as a national project in order that all present and future Sections can be assured of plenty of good speakers.

Your editor is not in a position, nor has he the authority, to pursue this subject further, officially, but any suggestions, comments, ideas, or reports of similar activity by other Sections will be welcomed and will be publicized in

the JOURNAL. These "communiques" will also be placed in the hands of the proper parties if and when such a project is undertaken on a national scale. —RRP.

Editor's Notes

1. CALENDAR OF EVENTS

Beginning with this issue, the Calendar of Events will become a regular feature of the JOURNAL. This method of announcing forthcoming meetings was in use in INSTRUMENTS for some time before the formation of the I.S.A. When the JOURNAL was started, the feature was not included because it was felt that the proper place for such announcements was in the Section News department. Now, however, with more and more Sections being added to the list, the job of securing advance information and editing the Section News material has become more and more complicated. By combining all meeting announcements in one chart, and by supplying each Section with pre-addressed stamped post cards, the Section News material can henceforth be simplified and the Section Secretaries or Correspondents will find it easier to get advance information to us in time to be useful and in a form that requires no editing.

The response to our first issue of these postcards was very gratifying. One thing we would like to point out, however, is that all material for the JOURNAL is prepared from two to three weeks before its publication. Many of the cards we have received list a meeting which will occur before the next issue of the JOURNAL appears; hence, such reports are useless as advance information for the Calendar of Events. Addressing ourselves particularly to the Section personnel responsible for sending in these cards, we would like to again emphasize that in order for advance notices to be useful and give each Section the publicity it should receive in the Calendar, the cards should reach the Editor before the last day of any month and contain advance information on a meeting which will occur *after* the 20th of the following month (the month of publication).

Until the program gets well under way, we are sending reminder letters to each Section in plenty of time each month for them to be answerd in time for the requested information to be published. We would like to see all Sections represented in future publications of the Calendar of Events.

2. THE NEEDLE POINTS TO—

Detroit, for one of the easiest-to-read reports we've had the pleasure of editing.

Northern Indiana, Philadelphia, Sarnia, South Texas and Twin Cities (little Needles) for above-average reports.

Official News

TO ALL SECTION SECRETARIES

Already there are changes to be made in the list of Section Secretaries, Directors and JOURNAL Correspondents published in last month's issue. These are as follows:

NEW ORLEANS: Change of address of Secretary. New address is W. H. Haney, 2927 Music St., New Orleans, La.

PHILADELPHIA: New JOURNAL Correspondent: John C. Koch, Conoflow Corp., 2100 Arch St., Philadelphia 3, Penna.

SOUTH TEXAS: New JOURNAL Correspondent: L. Needham, 405 Beverly Drive, Corpus Christi, Texas.

MEETING PLACES CHANGED FOR NEW YORK REGIONAL CONFERENCE

The Hotel Pennsylvania has been secured for most of the activities of the I.S.A. Regional meeting to be held in New York City on January 30 and 31, according to latest reports from the committees in charge. The program as outlined in the December issue of the JOURNAL was tentative, and listed the Engineering Societies Building as the location of some of the sessions. However, with the completion of final arrangements with the Pennsylvania, all functions except the Saturday afternoon session on Computers will be held in the hotel. The Saturday afternoon session is still scheduled to be held at Columbia University.

Official programs have been mailed to all members. For the benefit of non-members who did not receive the official program, following is a condensed schedule:

Friday, Jan. 30, 1948 (Hotel Pennsylvania, Georgian Room)

9:00 AM—REGISTRATION
9:30 AM—OPENING GREETINGS
9:45 AM—Technical Program, Dr. James Mouzon, Brown Instrument Co., Chairm.
(Papers on Thermistors, Thyrite, Germanium Rectifiers, and Humidity Measurement.)
2:00 PM—Technical Program, H. L. Hildenbrand, Chairman.
(Papers on Strain Gages, Light Sensitive Devices, and Conductivity Measurement)
6:00 PM—SOCIAL HOUR
7:00 PM—DINNER MEETING, featuring "ELECTRONIC FANTASIES" by R. R. Batcher, Electronic Industries, N.Y.C. (A popular showing of interesting, if not always simple, ways of handling trivia by electronic methods.)

Saturday, Jan. 31, 1948 (Hotel Pennsylvania)

9:00 AM—REGISTRATION
9:30 AM—Technical Program, Perry Borden, The Bristol Co., Chairman
(Display and discussion of Electrical Types of Recorders and Controllers, by C. O. Fairchild, Consultant and Past President of the I.S.A.)
12:00 N—ADJOURNMENT (Note: The afternoon Technical Program will be held at Columbia University, 116th Street and Broadway—a short subway ride from the Hotel Pennsylvania.)
2:00 PM—Technical Program, Prof. Carl F. Kayan, Chairman. (Columbia University.)
1—Electronic Techniques in Continuous Type Computers, by Prof. John B. Russell.
2—Digital Computing Devices and Their Application to the Solution of Technical Problems, by Wallace J. Eckert (Watson Scientific Computing Laboratories.)
(Both these papers will include descriptions and actual demonstrations in Columbia's laboratories.)

Concurrent with the Friday Technical Program, an Instrument Maintenance Short Course will be conducted at the Hotel Pennsylvania. The schedule is as follows:

REGISTRATION—9:00 AM
TWO SESSIONS—9:30 AM to 12:30 PM and 2:00 PM to 4:30 PM.
(Work covers application, installation techniques, examination, tools and equipment, repairs to mechanism, electrical calibration procedures, and discussion of principles, circuits, variations in construction, record keeping and questions. A working knowledge of Ohm's Law and the basic principle of operation of the D'Arsonval movement is presupposed.)
Speakers are: E. R. Manning, Weston Electrical Instrument Company; H. C. Nilsson, Nilsson Electrical Laboratories; Chas. Haggerty, Instrument Engineer, Dept. of Public Works, New York City.

Additional pertinent information:

Registration starts at 9:00 AM Friday, January 30, in the Georgian Room of the Hotel Pennsylvania, 33d St. and 7th Ave. Registration fee of $2.00 covers Technical Sessions and Short Course.

Luncheons—no formal arrangements.

Dinner Meeting—informal. $4.50 per person.

For additional information on program write Ralph R. Batcher, 480 Lexington Ave., Room 635, New York 17, N. Y.

Advance Reservation and Hotel Reservation Service—write to Conference Secretary. (Norman Cherry, 633 Willis Ave., Merrick, Long Island, New York.)

Section News

ARUBA

The second annual banquet for the installation of the new officers of the Aruba Section was held November 15 at the Flamingo Room of the Deveer Theater Building. There were approximately 45 people in attendance, including members and guests and their wives. Master of Ceremonies for the evening was Howard Daudet.

Following a brief installation ceremony at which the new President, Jimmy Lopez, was presented with the gavel of the office, the guest speaker of the evening, Mr. C. Tuininga, was introduced. Mr. Tuininga is Chief Instrument Engineer for the Shell Oil Company's subsidiary (CPIM) in Curacao, N.W.I. He presented a very clever and well-prepared talk tracing the growth of automatic control; the cleverness was in his accompanying analogy of the battle of the sexes. His talk was aimed at the ladies, and was well received by all.

Jim Faucett, our alternate Director, who represented the Aruba Section at the Chicago Conference in September, gave a brief talk covering his visit.

This was the first gathering of the Section at which the members' wives were included and the general opinion is that the affair was highly successful and should be repeated from time to time.

—LEROY L. MCGR[illegible], Corr.

CHARLESTON

Mr. Ralph Clarridge, Manager of the Application Engineering Division of the Taylor Instrument Companies, was the speaker at the December 1st meeting of the Charleston Section. His subject was "Instrument Application Outside the Chemical Industries."

The election of new officers was also held at this meeting, the results of which will be announced later. —CARL CAVENDER, Secy.

CHICAGO

The December 8th meeting was held in the Sun Room of the Furniture Club, where nearly 90 members and guests heard Mr. J. B. McMahon speak on the subject of "Flow Metering."

Mr. McMahon (Mac), a member of the Chicago Section and of the I.S.A. Executive Committee, is Application Engineer for Republic Flow Meters Company of Chicago. His subject, of interest to all but a difficult one for originality, was ably handled with the aid of slides and considerable personal comment. The discussion which followed dealt mainly with accepted standards, namely those of the A.S.M.E., the Bureau of Mines and the A.G.A. Mac intimated that the field was wide open for a standardized Flow handbook. That he be the author was proposed by many present.

The schedule for the balance of the season is:

Jan. 5—Albert F. Sperry, 'Servomechanisms." (Phil Smidt's)

Feb. 2—G. W. Baughman, "Instrument Applications in Railroad Signalling." (Furniture Club)

Mar. 1—Panel Session on Instrument Maintenance, L. C. Laird, moderator. (Peoples Gas Bldg. Auditorium)

Apr. 5—R. J. Kryter, "Atomic Power and the Atomic Bomb." (Builders Club)

May 7—Social Night, with installation of new officers. (Place to be announced)

—O. J. LESSA, *"Events" Ed.*

CUMBERLAND

The November meeting of the Cumberland Section was held at the Algonquin Hotel on Tuesday, November 25. Mr. C. B. Moore, of Moore Products Company, was the guest speaker.

Mr. Moore's subject was "The Solution of Instrumentation Problems by the Pneumatic Null Balance Method." This method, being somewhat new to many of the audience, proved to be very interesting. With the aid of slides, Mr. Moore fully explained the operation and uses of pneumatic null balance instruments. A lively informal question and answer session followed the talk.

—G. WILLIAM HARRISON, *Corr.*

DETROIT

Those who were out to the November meeting to hear Harry F. Moore of the Standard Oil Company describe how to set up a good instrument service organization got a lot of good new ideas. The only disappointment was that there were not more "hirers of men" present who have followed the out-moded theory that "if a man's no good at anything else, put him in the instrument department" simply because God made every man good for something.

Harry reported that in the east one could expect from 10% to 25% of all instrument men to be material out of which could be developed instrumentation engineers. This average is probably somewhat high for the Detroit area, perhaps not so much because better men are available in the east, but rather because of a screening technique in his organization which should be the envy of any plant in Detroit.

It is apparent that modern management is beginning to look upon the cost of instrumentation and its maintenance not so much as an operating expense that must be kept down but rather as a contribution to efficient production for which wisdom dictates the expenditure of a more generous portion of operating costs.

Harry explained how to develop those men who are capable of going to the top rung of the ladder. Now it's up to someone to explain how to stop a good man from learning too much, so he can be kept happy checking thermocouples to make sure the man at the top can depend upon a good man at the bottom to execute his ideas.

That's all to report this time except that Harry Osgood couldn't overlook the chance to slip in a good commercial movie for the Fulton-Sylphon Company and make everybody like it. —DON CAMPION, *Acting Corr.*

I.S.A. CALENDAR OF EVENTS

Section	Date of Next Meeting	Type	Place	Speaker	Subject
Alaska					
Baltimore					
California					
Central Indiana					
Charleston					
Chicago	2/2/48	DXX*	Furniture Club	G. W. Baughman, Union Switch & Sig. Const. Co.	"Instrument Applications in Railroad Signalling"
Cincinnati	1/26/48	M8	Eng. Soc. Bldg.	Gordon Volkenant, Minneapolis-Honeywell	"Electronics Made Simple" (Joint session with Cin. Sec. A.C.S.)
Cleveland	1/28/48	DX8	Cleve. Eng. Soc.	R. A. Rockwell, Mason-Neilan	"Liquid Level Measurement and Control"
Cumberland	1/27/48	DX8	Algonquin Hotel	J. B. McMahon, Republic Flowmeters	"Experiences of an I.S.A. Man Abroad"
Detroit	1/27/48	M8	Rackham Bldg.	T. S. Cawthorne	"A-C Measurement" (Also informal discussion)
Eastern New York	2/3/48	M8	Siena College, Albany	W. W. Matlack, Brown Inst. Co.	"Automatic Temperature Measurement and Control"
Gulf Coast					
Kansas City	1/27/48	D6X	The Crossroads	W. W. Wheeler, Askania Reg.	"Automatic Controls, Application to Proportioning of Fluids."
Louisville					
New Jersey	2/10/48	D68	Essex House, Newark	Gordon Volkenant, Minneapolis-Honeywell	"Demonstration of Electronics"
New Orleans					
New York	1/30/48 1/31/48	** **	Pennsylvania Hotel	**	*Regional I.S.A. Meeting
Niagara Frontier					
Northern Indiana	1/21/48	DXX	Lake Hotel, Gary	Instructor Purdue Univ. Ext.	"Physics Referendum"
Oak Ridge					
Ontario					
Philadelphia	1/21/48	M8			
Pittsburgh					
Presque Isle					
St. Louis	2/4/48	DX8	Engineers Club	G. W. Baughman, Union Switch & Sig. Const. Co.	"Instrument Applications In Railroad Signalling"
Virginia	2/20/48	M8	Moose Hall	L. A. Gilbert, Polymer Corp.	"Principle of Operation of Bailey Combustion Controls" (Also film "Properties of Water").
South Bend					
Southern Michigan	2/18/48	DX8	Chicken Charlie's, Kalamazoo	F. G. Tatnall, Baldwin Locomotive Works	"Strain Gages"
South Texas	2/3/48	MX	CP&L Auditorium, Corpus Christi		Technical Meeting and Installation of Officers
Tennessee					
Tulsa					
Twin Cities	1/27/48	DXX	University of Minn.	F. R. Davis, Davis Emerg. Eqpt. Co.	"Gas Measuring and Analyzing Equipment"
Washington					
Wayne Co.	2/16/48	DX8	Presbyterian Church House, Wyandotte	Hart Fisher, Mansanto Res. Dept.	"Training Instrument Personnel"

*LEGEND: Meeting only, no dinner—M7, MX or M8 (7pm, 7:30 pm or 8 pm respectively) Dinner meeting—first symbol D; second symbol time of dinner (6 for 6 pm, X for 6:30 pm, 7 for 7 pm); third symbol time of meeting (7 for 7 pm, X for 7:30 pm, 8 for 8 pm).

**See official folder for registration and program details.

NEW JERSEY AND NEW YORK

The New Jersey Section held its annual joint meeting with the New York Section at the Essex House in Newark on November 11. The turnout was one of the largest ever experienced by this Section, there being approximately 150 persons present. Of this group, about 30 members were present from the New York Section, approximately 80 from the New Jersey Section, and the balance were guests.

The speaker of the evening was Mr. Richard Pond of the Taylor Instrument Companies of Rochester, New York. Mr. Pond's subject was "Demonstration of Automatic Control Principles," and his presentation was divided into two sections. The first part pertained to the story of a chemical manufacturer and his problem of obtaining an automatic control for controlling the operation of an oven necessary in the manufacture of his product. The various types of control systems were described, starting from the on-off control and continuing on with throttling, or proportional, reset and rate action control.

The second part of the talk consisted of a demonstration utilizing a liquid level control process with each type of control being described and demonstrated. The demonstration of the operation of this equipment was quite unique. Mr. Pond had set up a special strip chart recorder with a wide chart to record the results of the operation of the various types of control.

In addition to the main feature of the evening, a display of regulating valves was set up by the Foster Engineering Corporation. This is a new feature of the New Jersey Section. Professor Creger of Rutgers University is in charge of a committee to arrange exhibits at each meeting.

—W. H. SHELLENBERGER

The New Jersey Section held its December meeting on Tuesday, the 2nd, also at the Essex House in Newark. Mr. Coleman B. Moore, senior partner of Moore Products Company, was the speaker. His subject was "The Solution of Instrument Problems by the Null Balance Method." Mr. Moore had presented a talk to this Section last year, and it was anticipated that he would introduce some new approaches to the problems encountered in the Instrumentation and Control field. It can be added that none of his listeners were disappointed.

—H. M. MCCARTHY, *Corr.*

(Continued on page 86)

The Fundamentals Of Radioactivity *

By DR. C. J. OVERBECK

(Professor of Physics, Northwestern University, Evanston, Ill.)

MAN stands unique among all animal life in his ability to fathom the intricate secrets of nature. His new discoveries, and particularly his use of them, require a constant revision of his concept of the physical universe and his mode of living. Recently we celebrated the half-century anniversary of such an epoch-dating discovery by the famous French Physicist, Becquerel—the process of radioactivity. This discovery, in 1896, of the natural transmutation of the nuclei of atoms of Uranium salts showed, first, that the nucleus of an atom is not a fixed entity which never changes, and, second, the process of change or transmutation involves the release of energy of astonishingly huge magnitudes.

Investigations which followed this new concept of the make-up of matter and the meaning of energy, have been fruitful both theoretically and in practical application. It is my assignment in this symposium to review briefly and very simply some of the fundamentals involved. The new words and ideas introduced—tools of science—become common property quickly. Recently a friend, bus-waiting in Washington, watched two boys jostle on a street corner. Presently one stopped, looked at his partner and said, "You know what's wrong with you?" And after a moment added, "You've got too many deutrons in your nucleus." Whether or not there was a reaction, I do not know. I do know that the radioactive process follows an unstable nuclear condition.

Within a short time after Becquerel's discovery, the Curies established the fact that other elements, notably polonium and radium also possessed unstable nuclei, in fact were even more radioactive. It is now known that some forty elements belong in this group which exhibit the property of spontaneous disintegration or emission from their nuclei of mass particles and energy. They are heavy atoms of atomic weight above 208.

You will recall that the atom, as indicated by present evidence, consists of a very massive positively-charged nucleus about 10^{-12} cm. in diameter with electrons moving in definite orbits, to about 10^{-8} cm., around it. It is frequently compared to a miniature solar system consisting largely of empty space. The positive charge of the nucleus, called its atomic number (Z), is equal in magnitude to the normal number of extra-nuclear electrons. This gives the atom its chemical characteristics, distinguishes one element from another and determines its position in the periodic table. We now recognize, including the recently man-made atoms, approximately one hundred chemically different kinds of atoms or elements.

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

The Author

Dr. Overbeck attended Vincennes University, the University of Michigan, Indiana University and Northwestern University. He received his A.B. degree in 1925 and his M.A. degree in 1926 from Indiana University, and his Ph.D. from Northwestern University in 1931. During these years he also served as Science teacher in Indiana public schools, Assistant in the Department of Physics at Indiana University, and as instructor in the LaSalle-Peru Junior College, where he organized their college Physics course. In 1927 he became an Instructor in the Department of Physics at Northwestern University and has remained there since. He is now Professor of Physics in that department.

Of these, hydrogen, Z = 1, is the simplest, and Uranium Z = 92, is the most complex of the natural atoms.

The weight of the atom increases with its atomic number. This number is usually expressed relative to the weight of an oxygen atom taken arbitrarily as of atomic weight 16,000. Using this basis, the hydrogen atom has an atomic wt. approximately 1, and Uranium 238.

The original concept that the nucleus consisted of a single indivisible unit was changed with the discovery of radioactivity. The next concept was that the nucleus consisted of an aggregate of similar particles. This had to be discarded when tests showed that a single sheet of paper served as a

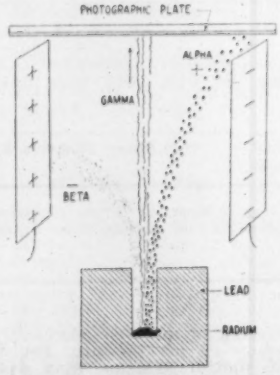


Fig. 1. Separation of α, β and γ radiations by electrostatic field.

shield for much of the radiation emitted in radioactivity while additional sheets had little additional effect. Evidently more than one particle was emitted, and evidently they had different penetrating powers.

What are these particles that come from the atom nucleus? You will recall the classical experiment of placing the radioactive material at the bottom of a hole drilled in a block of lead. The walls thus absorbed all emission except that directed up the hole. To test for a possible charge, an electrostatic or magnetic field was suitably placed above the hole to deflect and separate such charged particles, if present, and a photographic plate was placed in a horizontal plane above the hole to record the emission. Fig. 1 is a diagram showing this arrangement. After exposure and subsequent development of the plate, three spots were found, evidence of three distinctly different types of radiation. They were named α, β and γ rays.

The α ray spot was found to be formed by the deflection of a positively charged particle of atomic weight approximately 4 and charge +2, the nucleus of a helium atom. Its velocity of emission depended on the emitting element, having generally a definite value for each source. This is of the order of 10^9 cm/sec., giving it an energy of several million electron volts. Its ionization track is normally straight as shown in Figures 2 and 3, since it is perceptibly deflected only by the nuclei of atoms. The α particle has a tremendous ionization power, producing thousands of ions in a short track a few cm. of air under standard conditions. It soon loses its energy, however, and finds a pair of electrons to become a helium gas atom.

The β spot is formed by negative particle deflection. A study of the characteristics of this particle classified it as an emitted high speed electron of charge −1 and of negligible mass. The velocity of emission, from any given element, varies greatly ranging from a third the velocity of light to nearly the velocity of light. Compared to the α particle, its ionization power is weak, but its penetration of the average is a hundred times greater. The fastest β particle can penetrate a few mm. of lead and a greater thickness of lower density materials. Its ragged path is evidence of its small mass. See Figure 2(b).

The γ spot is undeflected in the field, thus the γ ray carries no charge. Its penetrating power is some 10,000 times that of an α particle. It can transfer its energy, all or in part, to an electron, which then acts as a comparable β particle. The γ ray has no mass in the ordinary sense of the word. It is an electromagnetic wave of wavelength 10^{-8} to 10^{-11} cm, comparable to the radiation involved in a several million volt X-ray (Figure 3(c).)

Thus, we see that the parent atom loses helium nuclei, electrons and electro-magnetic wave energy. What becomes of the parent atom? When the metal radium (See table I) emits an α particle, the remaining nucleus is a gas atom of the new element radon.

But radon, in turn, having an unstable nucleus, emits an α particle and forms the solid radium A, which is also radioactive. In turn, radium B is formed. This atom, however, emits a β particle. The mass change is therefore so small that we may ignore it here, but

nucleus, losing one negative charge, omes one unit more positive.

And so the process continues as a ies of explosions, thus relating many the radioactive elements to a single ent atom. There are, in fact, two ncipal series or families, (a) the anium Series, from which branches Actinum Series and the (b) Thori- Series. The final stable atom is d. The Uranium Series leads to a d atom of atomic weight 206. The rium series leads to a lead atom of mic weight 208. Physically these ms are different; chemically, since h have the atomic number 82, they alike. They are isotopes of lead.

So far we have said little about the rgy involved. Chemical reactions in- ve a few electron volts per atom. e energy, released in radioactivity d other nuclear phenomena, is of the er of millions of electron volts. You y recall that in the case of radium energy release is more than suffi- nt to heat its own mass of water m the freezing point to the boiling nt every hour continuously for near- 1700 years before half of the radium disintegrated. It is not surprising refore to recognize that the rate of ay is fixed by nature. No known oratory condition of temperature, ssure, etc., or chemical treatment change the rate of transformation. ch has its own characteristic "half- e" which is the time required for f the nuclei present to emit their diation. For example, radium has a lf-life" of approximately 1700 years. is means there is a fifty-fifty chance t an α particle will succeed in aping from the parent atom within next 1700 years. If there are a at many radium atoms present, half them will lose α particles in that e. Each of the remaining atoms still a fifty-fifty chance to lose an α rticle in the next 1700 years: and f of the remaining atoms will suc- d in that time.

If N_o represents a given considerable mber of radioactive atoms, and N_t number remaining after a time t:

$$N_t = N_o e^{-\lambda t}$$

ere λ is the decay constant, that is, fraction representing the relative mber of atoms that disintegrate per it of time. For the "half-life"

$$N_t = \frac{N_o}{2}$$

$$t = 1/\lambda \qquad \log_e 2 = \frac{0.69}{\lambda}$$

The half-life as noted in Table I ries from a fraction of a second adium C') to billions of years (uran- n I). The parent atom of the series st necessarily be one of large half- e since only that type of atom would ve survived, in any reasonable ount, the great age of the earth. e presence of short-lived elements bsequent to the parent atom is pos- le since such elements are continu- sly being produced. In fact, after a sonable time the subsequent radio- tive elements must exist as a con- nt number of atoms. That is, the mber of atoms disintegrating in a ven time must be just equal to the mber of new atoms of that element rmed in that time. This is expressed Table I under the heading "Equilib- m Amount." Thus one grain of

Table I

The Uranium Series

Element		*At. Wt.*	*At. No.*	*Radiation*	*Half-Life*	*Equilibrium Amt.-Mg.*	*Range cm. air.*	*Vel. cm. sec.*
Uranium	I	238	92	α	4.6×10^9 yrs.	2.8×10^9	2.7	1.4×10^9
"	X_1	234	90	$\beta + \gamma$	24.6 days	.04		
"	X_2	234	91	$\beta + \gamma$	1.15 min.	13×10^{-7}		
"	II	234	92	α	2×10^6 yrs.	1.2×10^6	3.3	1.5 "
Ionium		230	90	α	76,000 yrs.	41000	3.2	1.48 "
Radium		226	88	α	1690 yrs.	1000	3.39	1.51 "
Radon		222	86	α	3.85 days	.00625	4.1	1.61 "
Radium	A	218	84	α	3 min.	34×10^{-7}	4.72	1.69 "
"	B	214	82	$\beta + \gamma$	26.8 min.	3×10^{-5}		
"	C	214	83	$\alpha + \beta + \gamma$	20 min.	22×10^{-6}		
"	C'	214	84	α	10^{-6} sec.	(Neg.)	6.97	1.92 "
"	D	210	82	$\beta + \gamma$	25 yrs.	9.8		
"	E	210	83	$\beta + \gamma$	5 days	.0081		
"	F	210	84	α	136 days	.22	3.93	1.59 "
(Polonium)								
"	G	206	82	stable	stable	(6,800,000)		
(Lead)								

radium will be found in about three million grams of its parent ore Uranium.

Since for equilibrium, the same number of atoms of each element disintegrates in a given time, it follows that those of small equilibrium amount must have a high radioactivity or short half-life. For example, 1000 mg. of radium is in equilibrium with .00625 mg. of radon. See Table I. Thus "weight for weight", radon is 161,000 times more radioactive than radium. The unit curie (c) is based on this. It represents the quantity of the material in radioactive equilibrium with one gram of radium—one curie of radon weighs .00000625 gm. The absolute number of disintegrations per second in a curie unit is approximately 3.7×10^{10}.

The International Radium Standards Commission suggests that the curie be used only for members of the radium series. A unit called the Rutherford (rd) has been proposed for general use. It is the amount of any radioactive isotope which disintegrates at the rate of 10^6 disintegrations per second.

The roentgen (r) unit was originally developed for use as a unit of radiological dose. As defined (1937) it is "that quantity of X or gamma radiations such that the associated corpuscular emission per .001293 gm. of air produces, in air, ions carrying 1 electrostatic unit of quantity of electricity of either sign." It will produce 1.61×10^{12} ion pairs per gm. of air.

The roentgen is really a unit of "quantity of ionization" under specified conditions. No time unit is involved. Dosage rates are, therefore, expressed in terms of roentgens per unit time. Thus for a maximum 24 hour exposure of 100 mr the rate (continuous) would be

$$x^{mr}/_{hr} \times 24 \text{ hr} = 100$$
$$\text{or } x = 5^{+mr}/_{hr}.$$

Since no physical or chemical means are known which can affect the rate of radioactive disintegration of the heavy atoms, it is evident that the nuclear forces which control this phenomenon must be very great and/or the nucleus must exert a great repelling force to outside disturbances. If we are to attack the nucleus and disturb its binding forces, it is necessary that the approach be to within nuclear dimensions (of the order 10^{-12} cm.). Logically the projectile should be a high speed atomic particle.

In the early development of this field, to about 1920, the most suitable and energetic particles available were α particles produced by radioactivity. These carried some 5 Mev. energy. Could a direct collision between an α particle and the heavy atom nucleus produce a sufficiently close contact to disturb these nuclear binding forces? It is not difficult to compute the required projectile energy, considering only electrostatic repulsion, between the two charged particles, projectile and nucleus. The energy W required would be given by

$$W = \frac{Zze^2}{r}$$

where Z is nuclear charge and r the distance of nuclear approach. For the heavy atoms this computation predicts that several hundred million electron

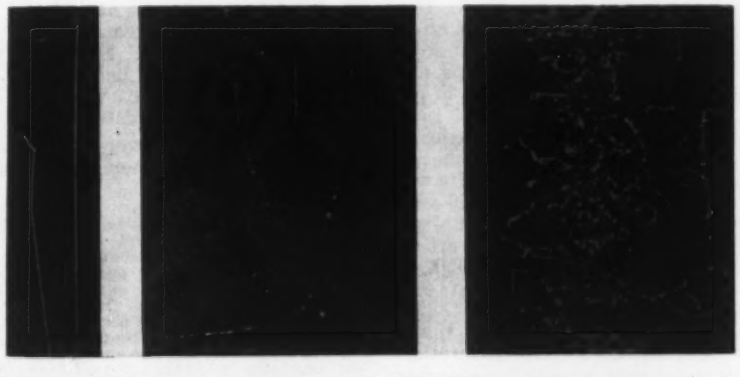


Fig. 2. Cloud chamber photographs of (a) tracks left by two alpha particles, (b) a beta ray, and (c) ionization produced by a narrow beam of X-rays.

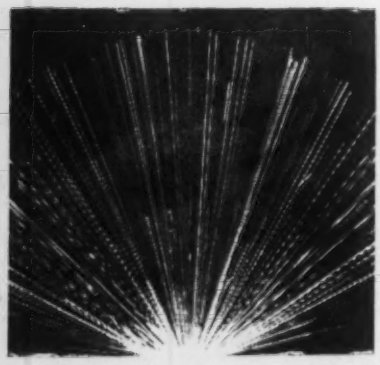


Fig. 3. Tracks of alpha particles from thorium (C and C1) in a Wilson cloud chamber showing the two ranges.

volt energy is necessary. The α particle is much too weak to be used as a projectile for the massive atoms. Since the required energy decreases as the nuclear charge, the α particle does have enough energy to approach, to within 10^{-12} cm., the light atoms.

In 1919 Lord Rutherford was successful in producing collisions of this type between swift α particles from a radioactive source and the nuclei of Nitrogen gas atoms. An occasional α particle, several per million, by chance struck a nitrogen atom nucleus squarely, and a new particle, the nucleus of a hydrogen atom, of very long range was ejected. (See Figure 4). In his modest manner Rutherford reported this as follows: "It is difficult to avoid the conclusion that the long range atoms arising from the collision of α particles with nitrogen are not nitrogen but probably hydrogen. If this be the case, we must conclude that the nitrogen atom is disintegrated under the intense forces developed in a close collision with a swift alpha particle and that the hydrogen atom (proton) which is liberated formed a constituent part of the nitrogen nucleus." Symbolically this may be expressed as

$$_2He^4 + {}_7N^{14} \rightarrow {}_8O^{17} + {}_1H^1$$

This was the first time man was instrumental in changing an atom of one element into another, but he did have to use energy supplied directly by nature. The α particle, which served as a projectile in this transmutation, is in reality only a high speed helium nucleus carrying its several million electron volts of kinetic energy. There are laboratory methods to strip one or more of the outer electrons from helium, or other atoms, and thus produce charged particles. Such particles can be accelerated and given kinetic energy by suitable magnetic or electric fields. It is logical, therefore, to expect that an attempt would shortly be made to see if man-made projectiles of perhaps even greater energy, might not serve to produce nuclear transmutations.

Several devices were immediately available to accelerate these charged particles. Medical x-ray tube units were producing voltages up to 100,000 volts. By combining several of these units in an additive arrangement, Cockcroft and Walton constructed an 800,000 volt unit. With helium nuclei (charge 2) projectiles this would give 1.6×10^6 mev.—considerably less energy than α particles from radioactive materials.

Since the energy needed for a nuclear approach is reduced as the charge on the projectile is reduced, a hydrogen atom nucleus or proton could be given sufficient energy by this voltage.

In 1932 these scientists carried out the following experiment bombarding Lithium atoms with protons, It resulted in the formation of two high speed α particles

$$_1H^1 + {}_3Li^7 \rightarrow {}_2He^4 + {}_2He^4$$

as shown diagrammatically in Figure 5. This was the first evidence of nuclear transformation produced by a laboratory accelerated projectile.†

In order to attack the heavier nuclei, greater accelerating forces or voltages were needed. Several devices, notably the Lawrence cyclotron (Figure 6), the Van de Graaff machine, and the recent synchrotrons, have now pushed the value to many million electron volts. Elements by the score have had their atom nuclei changed by the intruding projectiles thrown by these devices. Much new information of nuclear structure has been gathered. The present emphasis is on obtaining 300 Mev.

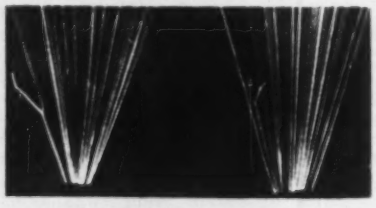


Fig. 4. The ejection of protons (in the forward direction) from nitrogen nuclei by alpha particles.

units which will reveal more nuclear detail and perhaps give understanding to the mesotron, those short-lived particles in cosmic rays suspected of being binding forces within the atom.

Rutherford believed that the proton, emitted when nitrogen was bombarded by α particles, came from the nitrogen nucleus and formed a constituent part of it. We are led to the same conclusion when we examine the atomic weights of isotopes. They are essentially a series of whole numbers. Lead, for example, has isotopes of atomic weights 204; 206; 207; 208. Since the proton (Greek—"first one") has unit atomic weight, perhaps these nuclei differ only in having additional protons. For this to be true, the atomic weight and atomic number of the elements must be the same. This is not the case. Therefore, scientists have speculated on the existence within the nucleus of an uncharged particle of about the same mass as the proton which was named the neutron. For years this remained a purely hypothetical particle. Since it must carry no charge, the usual manifestations of ionization etc., would be lacking and therefore its detection difficult.

The eventual discovery of the neutron was, like much of our scientific heritage, an international affair. The German scientists, Bothe and Becker (1931) found that the bombardment of beryllium by α particles produced an extremely energetic radiation. This was presumed to be a super-intense γ ray. A year later Curie and Joliot, the famous daughter and son-in-law of the discoverers of radium, observed that this radiation, when it impinged on hydrogen-containing mass, gave high energy proton cloud tracks. These tracks did not start at the beryllium. The measurements and computations of the English physicist Chadwick then proved that this mysterious radiation was in every respect the suspected neutron.

In the usual notation

$$_2He^4 + {}_4Be^9 \rightarrow {}_6C^{12} + {}_0n^1$$

This is an especially interesting and important transmuting agent since its lack of charge means that it is not subject to the repelling electrostatic forces of the nucleus. Thus it does not need great energy in order to approach the nucleus. Should a nucleus be in its path it may readily enter to produce a transformation. In fact it wanders about until this occurs. For certain transformations high kinetic energy is actually a detriment in such a search.

Additional evidence to indicate that the proton and neutron are basic nuclear units comes from the bombardment of the simplest composite nucleus, Deuterium, with γ radiation. This produces a proton and neutron

$$_1D^2 + \gamma \rightarrow {}_1H^1 + {}_0n^1$$

This is still another way to initiate a nuclear transformation.

Nuclear bombardment studies were stimulated in 1934 when M. and Mme. Curie-Joliot found that in certain cases the disturbed nucleus became radioactive. It opened the new field of artificial radioactivity. No longer was man dependent on the naturally radioactive elements for this phenomenon. The Curie-Joliot experiment, Figure 7, consisted of bombarding aluminum with alpha particles. This produced an unstable or radioactive phosphorus having a "half-life" of three minutes.

$$_2He^4 + {}_{13}Al^{27} \rightarrow {}_{15}P^{30} + {}_0n^1 \qquad \textit{Step (1)}$$

$$_{15}P^{30} \rightarrow {}_{14}Si^{30} + {}_1e^+ \qquad \textit{Step (2)}$$

Several hundred radioactive isotopes have since been produced. A number of these emit α particles, a unit consisting of two protons and two neutrons. Evidently this is a very stable unit. The rest of the radioactive materials release β particles or electrons in their transmutation. So far no mention has been made of electrons existing within the nucleus. What then is their source? In the light of present evidence it ap-

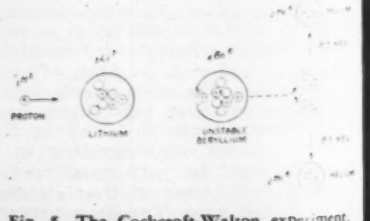


Fig. 5. The Cockcroft-Walton experiment. Disintegration of a lithium nucleus by a proton of 0.15 MEV energy.

†(ED. NOTE: In equations of the type shown here, the subscript numeral preceding the elemental symbol indicates the electrostatic charge on the particle, while the superscript numeral or exponent indicates the mass. For example, $_2He^4$ represents a helium nucleus carrying a charge of 2 units and having a mass of 4 units. For an equation to be in balance, the sum of the charges on one side must equal the sum of the charges on the other side; the same holds true for the masses.)

ears that the electrons come into existence at the time of emission. The proton and the neutron are regarded as two states of the same particle—sometimes referred to as the nucleon. An electron comes into being when one is converted into the other. The conversion of a neutron into a proton releases an electron. A positive electron of very short life is released in the reverse process. One might expect that all protons would be converted into neutrons. This would reduce the repulsion forces existing between the charged particles. The emission of α particles from the nucleus indicates that a combination of two protons and two neutrons forms an extremely stable unit. There is probably some balance between these opposing forces. It is known that light atoms tend towards equal numbers of protons and neutrons, while the heavy atoms have an excess of neutrons. We may be quite certain that stability is a question of whether or not a particular transformation consumes energy or releases energy. If extra energy is needed in the process, it will evidence stability.

The physicist is always interested in mass and energy relationships. Let us examine again the equation showing the result of bombarding lithium with protons which produced two high speed α particles

$$_1H^1 + {}_3Li^7 \rightarrow 2\,{}_2He^4 + 17 \text{ Mev of KE.}$$

On the right hand side we have in atomic weight units

$$_1H^1 = 1.0076$$
$$_3Li^7 = 7.0165$$
$$\text{Sum} \quad 8.0241 \text{ mass units.}$$

On the left hand side we have

$$2 \times 4.0028 = 8.0056 \text{ mass units.}$$

Thus there is a mass difference (loss) of .0185 atomic weight units or 3.05×10^{-26} grams but a gain of some 17 Mev energy. Mass was lost and energy gained in the process.

The explanation of such an unusual situation was already available. In 1905 Einstein's work in the development of the theory of relativity led him to the conclusion that the two laws, (a) Conservation of energy (b) Conservation of mass, were actually interrelated in a single law that "mass-energy can neither be created nor destroyed" and that the inertial mass of a body increases as its velocity increases. Experiments with high speed electrons showed that they did become more "massive" as their speed approached the velocity of light.

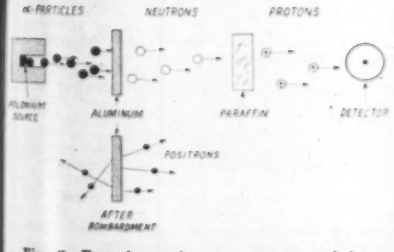


Fig. 7. Experimental arrangement used by the Curie-Joliots when they discovered induced radioactivity.

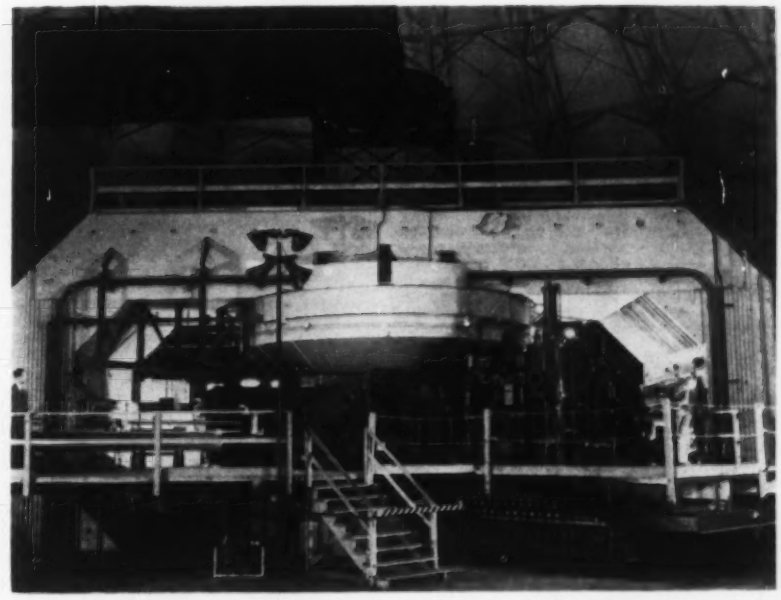


Fig. 6. A modern cyclotron. Photograph courtesy of Radiation Laboratory, University of California. (The cyclotron shown in the photograph has a pole diameter of 184 inches and the magnet weighs 4000 tons. It is operating in Berkeley as a synchro-cyclotron currently producing 200 MEV (million electron volts) deuterons and 400 MEV alpha particles.)

The conversion relationship of mass and energy is given by the simple expression:

$$E(\text{ergs}) = m(\text{grams}) \times C^2$$
$$(\text{vel. light in } {}^{cm}/_{sec.})$$

Since one electron volt energy is 1.6×10^{-12} ergs the energy in ergs of the two resulting α particles must be

$$17 \times 10^6 \times 1.6 \times 10^{-12}$$
$$= 27.2 \times 10^{-16} \text{ ergs}$$

The right hand side of the equation gives

$$3.05 \times 10^{-26} \times (3 \times 10^{10})^2$$
$$= 27.5 \times 10^{-6}$$

The balance tallies in a very convincing fashion. No attention was given to the kinetic energy possessed by the projectile. A few such refinements would give an even better balance.

Such computations are a means of determining the relative stability of the nuclei of matter. If the atomic mass of the atom parts exceeds that of the atom unit, it can only be disintegrated if an outside source can suitably supply the equivalent amount of energy. Helium has been named as being a stable unit. Its atomic weight and atomic number indicate that it is composed of two protons of atomic weight 1.0076 each and two neutrons of atomic weight 1.0089 each. These together have a combined value of 4.033 while the atom has an atomic weight of 4.003. Thus energy to the extent of .03 mass units would be required to break the helium atom into its component parts. The nucleus of the helium atom or α particle is an extremely stable unit. Actually approximately 190 million watt hours energy would be required to break up the nuclei of the helium atoms in a grain of the material.

Applying this test to the various element atoms, it is apparent that most of them are quite stable especially those nuclei in the middle of the periodic table. The heavy atoms at the bottom of the periodic table are the unstable ones, and it is in this group that natural radioactivity goes on.

Whether or not a helium nucleus or other particle leaves the rest of the nucleus is a matter of energy balance. The process can take place without outside assistance if energy is emitted. This is true for the radioactive radium atom which releases its α particle. Once the nuclear forces have lost their hold, the particle is pushed away by the positive charges on the remainder of the atom and an α particle of several Mev. energy is free. Other atoms require energy to remove a helium nucleus. Some two million electron volts are required in the case of oxygen. It, therefore, is a stable atom and will so remain until outside sources properly supply the energy.

Recently the study of nuclear physics revealed another type of nuclear instability. The heavy atomic nucleus, in the case of Uranium 235, may undergo an even more violent mass energy transformation in which it blows itself into two very nearly equal masses. In the process it loses mass and releases some 200 million electron volts of energy per atom. This is nuclear fission. Again the scientist found the key to produce in the laboratory other similarly unstable atoms. Unfortunately it was the stimulus of war that hastened these discoveries, and their first use in the destruction of life and property. The vast amount of energy which the process represents may eventually be the source towards which man must turn to continue life. Our energy balance each year has been in the red. We are rapidly depleting our coal and petroleum supplies. Restoration through photosynthesis is not sufficient.

The fifty years of scientific research in nuclear physics since the initial accidental discovery of radioactivity by Becquerel have been fruitful ones. Human beings hold the power to destroy this civilization or to construct a world of social advancement which can keep pace with its scientific and technical progress. This is our present problem.

(Continued from page 81)

NIAGARA FRONTIER

(Received too late for the December issue.)

The Niagara Frontier Section held its second fall meeting on October 24th at the New York State Institute of Applied Arts and Sciences. A short business meeting, including reports from the various officers and committee chairmen, preceded the technical program.

The speaker, Mr. Fred Trapnell, Instrument Engineer for the Dupont Company, Wilmington, Del., presented his interesting and thought-provoking talk on "Coordinated Process Control Systems." The talk was well illustrated by slides, and an active discussion period followed.

The Section was pleased to welcome representatives from the Chicago and Philadelphia Sections who were in attendance.

—RUSSELL MILHAM, *Corr.*

NORTHERN INDIANA

The November meeting of the Northern Indiana Section was held in the Lake Hotel in Gary on Wednesday, the 19th. Although the audience was small, indications are that attendance should start increasing from now on as the various new officers and new committees get under way. In a short business meeting, Vice-President Kenny Frame read a letter from Secretary Dick Rimbach clearing up several of the points about the relationship of the Section to the National Society which had not been clearly understood previously.

The speaker of the evening was Joe Connelly of the Foxboro Company, Chicago office, who presented an abundance of information about orifices that would be worth an evening of any instrument man's time. He stressed particularly the proper installation of the primary element, or orifice, saying that it was just as important, if not more so, than the selection of the meter or control instrument itself.

The regular December meeting was held on Wednesday, the 17th, also at the Lake Hotel in Gary. The speaker was Mr. Rudy Ericson of the Northern Indiana Public Service Company, who spoke on "The Engineering Approach to Service Engineering." His main advice to the listeners was that an instrument man should use his head rather than his hands in attacking a problem. Mr. Ericson described a Turbidity Meter and illustrated the applications of it.

The January meeting (Wednesday, Jan. 21) will consist of a "Physics Referendum" and the discussion leader will be an instructor from Purdue University Extension in Hammond. The February 18th meeting will feature Bob Larson of Wheelco Instruments Company who will describe their "Electronic Scriber" and its use.

—J. BAUM BECKMAN, *Corr.*

OAK RIDGE

The 20th meeting of the Oak Ridge Section was held at Grove Recreation Hall on December 3, 1947. Following the usual dinner, the meeting was opened by President B. B. Bell.

At the conclusion of the business portion of the meeting, the floor was turned over to the chairman of the program committee, N. L. Isenhour, who introduced the speaker of the evening. Followed then a very interesting talk on "Engineering Statistics" by A. H. "Andy" Fowler of the Instrument Engineering Department of Carbide and Carbon Chemicals Corporation at Oak Ridge.

The talk was begun by the proposal of a method of stating precision in a manner understandable and accurate through the use of fundamental statistics. It was pointed out that engineers, in performing tests, recognize the need for being precise in drawing conclusions, and that a statement of precision should not only include a band, such as a certain percent, but should also list the probability that a single observation will fall within this band. It was also brought out that all factors affecting the results of the data should be considered rather than taking into account only that phenomena which is known to disturb the precision. Actual data sheets from various instrument tests were presented for study.

The talk was concluded with the usual question and answer session, with the predominating query being along the line of "what is the probability of my rolling a seven before my point—five?"

Effective December 1st, Mr. Bell assumed the duties of President of the Oak Ridge Section, replacing former President C. W. Covey who has left to accept a position with the Taylor Instrument Companies at Rochester, N. Y. —J. O. ALEXANDER, *Corr.*

PHILADELPHIA

The Philadelphia Section met on November 19th at the Penn-Sheraton Hotel to hear an interesting talk by Mr. Edwin W. Anders, Vice-President of the Dehydraire Corporation and to learn the results of the election of officers for 1948. Mr. R. B. Werey, President of the Conoflow Corporation, gave a brief resume of the history of the conditioning (or lack of conditioning) of instrument air, and the importance of clean, dry air in the field of instrumentation. Mr. Werey then introduced Mr. Anders who presented the main topic, "The Design and Application of Instrument Air Dryers."

Mr. Anders stressed the point that manufacturing economies of production of the desiccant, simplified design, and quantity production on small units, have now put air dehydration within the reach of all users of air-operated instruments.

The talk was interesting and informative, as was evidenced by the questions from the floor at the conclusion of the formal presentation.

The results of the election were announced by President George Ehly. Those elected for the 1948 term were Garner C. Parr, President; Alfred Krieg, Vice-President; John C. Whiddett, Treasurer; and Clarence W. Wood, Secretary. Whiddett and Wood were elected by acclamation to fill the same offices that they held in 1947.

—JOHN C. KOCH, *Corr.*

SARNIA

The third meeting of this season was held Friday, November 21st. The meeting was opened with the showing of two films, "Distillation" by the Shell Oil Company and "Conservation of Hydro" by the H.E.P.C. A short business session was held during which it was moved that an Education Committee be formed to investigate the possibilities of organizing some instrument training courses in this district.

Two very capable speakers then took over. The first was Mr. J. W. Graeb, Instrument Engineer from the Engineering and Development Department of Imperial Oil, Ltd. He gave a very interesting and informal talk on "Selection and Installation of Control Valves." Mr. Graeb is no stranger to the Sarnia group, since before assuming his present duties he was Instrument Engineer of the Polymer Corporation, Ltd. Instrument Department here. Some very interesting points were brought out by the speaker on poor design and under-sized valves, wheer the by-pass must be used to the detriment of proper control. There was a question period in which some control valve problems were ironed out.

The second speaker of the evening was Mr. H. H. Barnum of the H. H. Barnum Company of Detroit. Mr. Barnum just carried on where Mr. Graeb left off, and gave some illustrations on the blackboard showing the principle of operation of the Springless Conomotor on "Saunders" valves. He showed some very good illustrations of the difficulty which occurs when controlling the flows of such products as slurry and pulp, and explained how they could be controlled by this type of valve with longer valve life and less maintenance. A question and answer period followed Mr. Barnum's talk.

Mr. Barnum congratulated the Sarnia Section on its interest and enthusiasm since its formation. He recalled especially that on Tuesday, November 18th, almost 30 members of this Section visited the Detroit Section to hear Harry Moore of Standard Oil present his paper on "Organization of the Instrument Department." (The boys enjoyed the speaker and the trip to Detroit very much and hope to visit the Detroit Section again.)

The meeting was adjourned at 10:30 p.m. and refreshments were served.

—L. GILBERT, *Corr.*

SOUTH BEND

The South Bend Section held its regular December meeting at the Engineers Club in the LaSalle Hotel on December 4th, with dinner at 6:30 p.m. and the meeting at 7:45. The speaker of the evening was Mr. G. D. Smith, of Sperry Products, Inc., Chicago office.

Mr. Smith's subject was "Supersonic Instruments" and during his talk he explained the use of, and described the principles of operation of the Sperry Reflectoscope and the Thruray for non-destructive testing of metals. The subject proved to be a very interesting one and drew several comments and questions from the audience.

—G. E. GILLIAM, *Sec'y.*

SOUTHERN MICHIGAN

The third meeting of the year was held at Chicken Charlie's in Kalamazoo on November 19, 1947. After introductions all around, Ed Stevens, technical chairman for the meeting, introduced the speaker, Mr. Art Wilson, Chief Engineer of [illegible] Engineering Company of Niles, [illegible]higan.

Mr. Wilson's talk was on the [illegible]bject of "Servomechanisms." He started [illegible]saying that instrumentation is no youn[illegible]fad, and one of the first servomechanism[illegible]was the guiding device on a horse (far-f[illegible]ched but amusing). He continued with a [illegible]scription of selsyn (or synchro) motors, [illegible]metallic remote level indicators, remote te[illegible]perature indicators, etc.

Several pieces of apparatus [illegible]ere displayed, including an electronical[illegible]braked electric motor, and a synchro tr[illegible]smission system set up by Wade Allen for the purpose of demonstrating the princi[illegible]e of operation.

A short business meeting followe[illegible] the talk.

The December meeting was held at Chicken Charlie's with a very satisfactory attendance despite slippery roads. Ken Mead discussed a contest to be held for the purpose of determining a name for the proposed announcement bulletin to be used henceforth by this Section.

Program Chairman Wade Allen then introduced the speaker of the evening, Mr. Roy Teetsell, Instrument Specialist of Westinghouse Electric Corporation, who presented a sound slide film on "Electrical Measuring Instruments—Their Construction, Operation and Selection." This sound film was prepared at quite some expense as an outgrowth of a course in instrumentation which was presented at a New York university, and was very informative. About half-way through the program, Mr. Teetsel interrupted the film to talk about the shock resistant meter, and proceeded to make everyone gasp when he purposely dropped the meter on the floor.

A lively discussion period followed the film during which such topics as accuracy, temperature coefficient, frequency response, and selection were brought up and ably handled by the speaker.

—R. J. SCHOFIELD, *Corr.*

SOUTH TEXAS

The South Texas Section held its December meeting on the 9th in the Conference room of the Southern Alkali Corporation plant. The speaker of the evening was Mr. Paul Condit, of the Esch-Condit Compa[illegible] of Houston, Texas, who spoke on the beginnings of recording and control instrumentation. He described the metamorphosis of the modern instrument man from the early "Pipe-fitter with his brains knocked out" to the "gadgeteer", thence to the point where he sprouted the wings (papier mache) of the engineer.

Mr. Condit advised all young students of instrumentation to take a course in psychology along with his engineering in order to enable him to cope with the problem of "wheedling" his future needs from the so-called "managers" of industry. He recounted how the installation of automatic control resulted in an 80% reduction of the labor force in a certain plant.

He also informed the group that the Massachusetts Institute of Technology now has a separate course in Instrument Engineering.

Two interesting items he displayed were drawings of a new automatic control valve by Annin, and a new valve of pure nickel made by his own organization.

The annual election of officers was held in December, with the following results:

President, W. A. Rock; First Vice-President, C. M. Carson; Second Vice-President, V. P. Nielson; Treasurer; J. K. Kalb; Executive Secretary, Homer C. Givens; Corresponding Secretary, L. Needham.

—L. NEEDHAM, *Corr.*

TWIN CITIES

The November 25th meeting of the Twin Cities Section brought out over 50 members and guests to hear three speakers discuss "New Wiring Methods."

Immediately following dinner, Mr. Gordon Johnson, of Spraywire Laboratories, Minneapolis, spoke on "Spraywiring Techniques," followed by Mr. Ralph Squier of Minneapolis-Honeywell, who discussed "Mechanization of Electronic Wiring."

Dr. Rodger W. Curtis of the U. S. Bureau of Standards was the feature speaker of the evening, speaking on the subject "Printed Circuits for Electronic Equipment." He wound up the meeting by telling of some of the procedures which have been developed by the Bureau for printing electronic circuits. He also showed slides illustrating the techniques, and also some small transmitters with the transmitting circuit elements printed on the outside of the envelopes of miniature tubes.

With circuit elements in this form, it is possible to construct transmitters in such things as lipstick and wristwatch cases.

A five-tube radio can be mounted on a card the size of a penny postcard and approximately ½-inch thick.

Those in attendance found the meeting extremely interesting, and spent considerable time afterward examining the samples and models which had been brought in by the speakers. —RAY HOPPER, *Sec'y.*

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA, 1117 Wolfendale St., Pittsburgh 12, Pa.

INSTRUMENT AND CONTROL ENGINEER (Chemical Engineer preferred) for the Development Engineering Dept. of large progressive concern. To coordinate instrumentation and control of several plants, develop standards, and to aid in measurements, instrumentation and controls incident to research and pilot scale experimentation. Box 99.

• • •

INSTRUMENT ENGINEER to select and develop mechanical instruments for the measurement of quantity (fluid flow, force, pressure) related to jet propulsion research. Some experience desirable. At least B.S. degree in M.E., Ch.E. or Physics. Box 100.

• • •

INSTRUMENT MECHANIC thoroughly qualified by experience in servicing of industrial process instrumentation. Must be well versed in measurement and control principles and capable of installing, calibrating and maintaining all types of mechanical, electrical and pneumatic instruments and auxiliaries. Starting rate $1.96 per hour with benefits and opportunities of a large company. Advancement to $2.03 per hour after 6 months. Location near Elizabeth, N. J. Box 101.

• • •

INSTRUMENT MECHANIC to maintain process control instruments, flow meters, pressure gauges, recording potentiometers, pH instruments in a paper mill. Location Western Maryland. Box 102.

• • •

ELECTRONIC ENGINEER for development work in the application of electronic circuits for operation of various types of laboratory equipment. By Research and Control Department of manufacturer of research and control equipment. Location Chicago. Box 103.

• • •

DESIGN AND DEVELOPMENT ENGINEER for constant-temperature appliance devices. Should have inventive ability to design new products as they are suggested. Must have a knowledge of electrical appliances, knowledge of refrigeration preferable. A prime requisite is an ability to work well with people and under pressure. Starting salary $4500 to $6500 per annum, commensurate with experience. Employing Company in business thirty years, designing, developing and manufacturing testing and laboratory equipment used in testing, locating, measuring, etc. Location Metropolitan Area of Washington, D. C. Box 104.

• • •

INSTRUMENT TECHNICIAN—opportunity for recent Mechanical Engineering graduate or man with comparable experience. To work for large brewery in Newark, N. J. Calibration of laboratory instruments. Salary good. Write stating age and experience. Box 105.

• • •

SALES REPRESENTATIVES in Minnesota, Northern Wisconsin, North and South Dakota, Montana, Kentucky, West Virginia, Western Pennsylvania, Maryland and Washington, D. C. Contacts with both jobber and industrial accounts necessary. Ohio Corporation producing a quality line of competitively priced panel meters. Reply giving list of lines and territory now covered. Box 106.

• • •

SALES ENGINEER for instruments and control equipment to central stations and large power plants. Must have technical education and have successful record in sale of combustion control, flow meters and allied equipment. Location Philadelphia, Pa. Age 30-40. Salary and bonus. Write age, experience, education and six references. Box 107.

• • •

INSTRUMENTATION ENGINEERS experienced in selection design and layout of chemical and industrial process instrumentation. Experience in actual installation of instruments desired but not essential. Positions offer good salary for those who qualify. Please submit complete resume stating experience (particularly mentioning types of instruments), education, salary requirements and date available. Location Cleveland, Ohio. Box 108.

• • •

INSTRUMENT MECHANIC for maintenance of instruments used in refinery processing 8000 bbls. per day of crude oil. Refinery consists of crude topping unit, T.C.C. catalytic cracking unit, a naphtha reformer, a polymerization unit and power plant. One man employed in this capacity and successful applicant would set up his own procedure of instrument maintenance. Location Michigan. Box 109.

• • •

ENGINEER for application engineering staff. Man with some experience in instrumentation, preferably in application work in the process industries. Engineering degree from recognized university preferred. Younger man, out of school 2 to 5 years. (Not required, however.) Box 110.

• • •

GRADUATE ENGINEER who would like to specialize immediately in instrumentation application work. Can use man who received educational training in chemical, mechanical or electrical engineering, provided that his interests were directed along proper lines. Box 111.

Who's Who in the I. S. A.

J. JOHNSTON, JR.

(Chairman, Subcommittee RP-8 of Recommended Practices Committee, "Instrument Tubing Protection and Support")

"Jack" Johnston, Philadelphia Section, has spent exactly half of his life in the instrument field. Now 30, working with instruments has been his primary interest for the past eighteen years. The first seven of those years were spent between the Brown Instrument Company (in inspection and testing of measurement and control apparatus) and Drexel Institute of Technology (majoring in Mechanical Engineering). He graduated from both in 1935, joining Standard Oil as instrument service technician at the Aruba (N.W.I.) refinery.

After a short stay at Aruba, Jack was transferred to Standard's refinery in Campana, Argentina, where he spent the next two years or so as a member of the Engineering Department in charge of instrumentation. He ended his stay there by getting married and returning to the U. S., where he became Instrument Service Engineer with Sun Oil Company at their Marcus Hook, Pa., refinery. During the latter part of his service with Sun, he became assistant to Ed Grace (Chief Instrument Engineer) and was put in charge of instrument design application, installation and maintenance.

In 1946, Jack joined Fred Trapnell's staff in the Design Division of the Dupont Company, and was recently transferred to the Consultants Group of the Industrial Engineering Division of Dupont's Engineering Department.

Jack's affiliation with Instrument Society work began with membership in the Philadelphia Section during its first year (1941). As Vice-President and alternate Director, he attended national organizational meetings in 1945, became President in 1946, and is currently a member of the Executive Committee. National activities include participation as a member of the 1948 Conference Committee and of the Recommended Practices Committee. His chairmanship of the Subcommittee (RP-8) on Tubing Protection and Support has not produced sufficient activity to permit the inclusion of a report with this article, he reports. He has prepared a questionnaire, however, in order to obtain preliminary information, and expects some results to be forthcoming before long.

Jack has one seven-year-old boy, and when not working or attending to domestic duties, devotes his spare time to photography, model railroading, radio tinkering, etc.

GEORGE F. GARDNER

(Director, Eastern New York Section)

Changing the meter charts in his home when he was twelve years old gave George F. Gardner an early interest in meters and instruments, and measurement is still his greatest interest.

After graduation from Gilbert School in Winsted, Conn., he started in the Test Program with General Electric Company, where he is now Division Engineer in the General Instrument Division of G. E.'s General Engineering and Consulting Laboratory.

Mr. Gardner is a member of a number of technical societies, among which are the American Association for the Advancement of Science, the Society of American Military Engineers, the Institute of Radio Engineers, and the Instrument Society of America, the latter of which he is a Director, serving the Eastern New York Section.

Personals

EXLINE TO TULSA

Paul G. Exline, President of the I.S.A., is now well established in his new role as Consulting Engineer in Tulsa, Oklahoma. This move, made in October, was not previously reported in these columns because of lack of details.

At the time of his election to the presidency, Paul was Section Engineer with Gulf Research and Development Corporation in Pittsburgh. At that time, however, he was completing his plans to set up his own organization in Tulsa, and his plans matured late in October. His new address is Exline Engineering Company, 710 S. Troost St., Tulsa 5, Okla.

According to a recent letter from Paul, he is equipped to do engineering design and development in the general field of mechanical engineering. Because of his past experience in instrument design and lubrication research, it is expected that these fields might predominate in his work. In order to round out the organization, he has acquired the services of a first-class electronics engineer.

Paul was the subject of a recent "Who's Who" article in these columns (see October 1947 issue of the JOURNAL). When he transfers his membership to the Tulsa Section, that Section can lay claim to being the youngest Section in the Society to have a national officer on its rolls—and President, at that.

Your editor would like to take this opportunity to wish Paul, on behalf of the Society, the best of luck in his new venture.